NEW SCIENTIST

5 March 1964

Can cross-Channel hovercraft pay?

DAVID FISHLOCK

The migrant scientist

LORD BOWDEN, *Manchester College of Science and Technology*

Pesticides and health

JOHN HILLABY

Government in 1984

Professor ASA BRIGGS, Dr V. K. ZWORYKIN, Professor RICHARD STONE and Dr ALEXANDER KING

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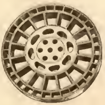

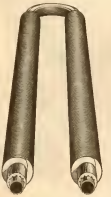

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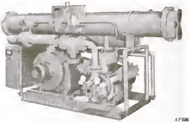

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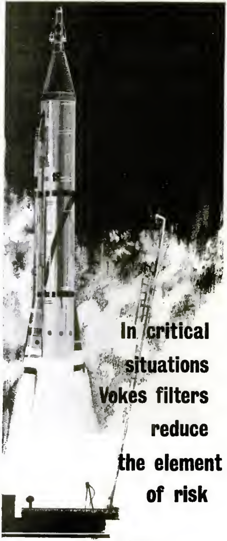
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Notes and Comments

Supersonic challenge

IN uncovering the A-11 reconnaissance aeroplane and announcing that it is capable of Mach 3, or something like 2000 mph at 70 000 ft, the United States authorities undoubtedly aimed at allaying doubts concerning materials and manufacturing methods figuring in their plans for a supersonic liner to compete with the Concord. President Johnson, in fact, alluded to success in the handling of titanium and, although he said nothing about the new sandwich plating, developed to allow steel to be used without having to pay heavy weight penalties, that, too, is certainly involved in the advanced technological processes to which he referred. These reassurances were particularly desirable after the difficulties which were encountered in the B-70 bomber project. The suspicion has been that this big, Mach 3 bomber was abandoned mainly because of structural difficulties arising from the high skin-friction temperatures.

While that undertaking was in hand, this smaller design, the A-11, was being pursued and it appears to have reached a successful conclusion. This aeroplane is probably one-third of the intended weight of the B-70. It is to be taken, therefore, as a small-scale exercise in the preparation of Mach 3 aircraft. In the aerodynamic sense Mach 3 presents no more stumbling blocks than does Mach 2.2. The challenge, especially in commercial aircraft, is to get a good combination of low-speed characteristics with economical performance at supersonic speed. The Lockheed Company, which was responsible for the design of the A-11, has sought to obtain this combination in much the same way as the Anglo-French designers of the Concord.

The wing of the A-11 is in the form of a double delta, extremely slender in its forward part and broadening out into a wider delta at the rear. That form is reproduced in the design for a supersonic liner submitted by Lockheed for the US competition. In the Concord, the wing is given a further refinement in its ogee form but the basic principle is the same. The A-11 differs from the liner design in having its engines (two, probably) set in the after part of the fuselage instead of in boxes under the trailing edge of the wing. That method was used in the Hustler bomber, which is capable of Mach 2.2.

Aerodynamically, then, the A-11 is not revolutionary. Its interest lies in the structure. Steel is a new material as applied to aircraft. Titanium is still newer and is attractive because of its low weight-to-strength ratio. Ways of giving thin-gauge steel the requisite strength have been devised and methods of sandwich fabrication have been worked out, but they are expensive and sometimes awkward where double curvatures have to be encompassed. Titanium is now produced in forms which overcome its original tendency to brittleness. Both metals will be used in hot spots on the Concord. In the A-11 they must have been used for complete structural sections and, if the aeroplane is as successful in service as it promises to be, the methods of fabrication and the construction which have gone to its making will be of the utmost interest. It is so nearly a one-third scale model of the Lockheed design for a Mach 3 liner that it may come to serve as a test bed for that project if it is chosen in May by the Federal Aviation Agency.

Going for a faster airliner, the Americans have serious engineering problems to cope with, but now that it turns out that those problems have already been tackled and solved in a small machine, it means that there can be no delay in the development of the Concord, if the expected "lead time" is to be preserved.

How France coordinates her research effort

IN the post-Trend period when Britain is trying to hammer out new patterns for the administration of science, the visit to London this week of M André Maréchal is timely. M. Maréchal, who is Délégué Général of Scientific Research, spoke to the Institut Français on research policy in France.

He said that the French research effort embodied a wide variety of forces and it was vitally important that they should be properly coordinated. This had been achieved by the creation of new organisations and by putting new ideas to work. Above all, a real research policy had been worked out. M Maréchal spoke of the three bodies—"nerve centres of research—physicists, biologists, agronbeen set up by the Fifth Republic.

At the top is the Inter-ministerial Committee, presided over by the Prime Minister, which takes the most important decisions in the matter of research. Then comes the Consultative Committee, composed of twelve leading personalities from the world of research—physicists, biologists, agronomists etc. This body advises the Prime Minister's Committee on scientific progress and equipment priorities, and suggests new administrative structures where these may be necessary.

The administrative basis of the committees is the Délégation Général. It is made up of about 100 members—economists, jurists, finance experts, and scientists of all disciplines. Embracing as it does a wide variety of specialists, it may be compared with other "horizontal" administrations which have been set up in France in recent years, of which the best-known example is the supreme planning body, the Commissariat Général au Plan.

The three bodies mentioned by M Maréchal cover research in all aspects. Their job is to coordinate and orien-

Notes and Comments *continued*

tate. Planning research, in M Maréchal's words, consists of suiting means to needs, in terms of objectives judged at the time to be possible and desirable, while avoiding waste and duplication of effort.

The research budget is tackled in an original way. Instead of each ministry discussing with the Ministry of Finance the whole of its allotment, research credits are detached from the budgets of certain ministries and collected together to be studied from every aspect each year in order to ensure a proper balance between the different sectors.

In cases where interesting results arose in an area involving several disciplines, M Maréchal said, extra funds would be supplied to laboratories, whether private or public, engaged contractually on such work. These "crash programmes" are financed for limited periods only.

The scramble of the new-born kangaroo

FOR a long time it was believed that young kangaroos were "born on the teat" in the mothers pouch, presumably by some process akin to the budding of a plant. When it was realised that marsupials had somehow, at their birth, to make the perilous journey to the milk supply when they were less developed than a mid-term tadpole, some scientific observers imagined that the female popped her young into her pouch with her paws, gave it a shove with her nose or her lips, or washed it in with her saliva. Today all these ideas are known to be incorrect, but until Mr G. B. Sharman and Miss Phyllis Pilton of Adelaide University actually watched what happened in the red kangaroos, it remained mysterious. Observations of five births have been published in the latest *Proceedings of the Zoological Society*.

During the hours before birth, the pregnant animal stood repeatedly cleansing the pouch by licking and appeared to be detaching a scaly, dark brown or black substance from the inside. A few minutes before birth, the female sat on the base of her tail, with the tail passed forward between legs and her back resting up against a wire fence.

When the new-born appeared, about three-quarters of an inch in length, it immediately grasped the surrounding fur with precociously developed claws and within approximately three minutes of vigorous action it had reached the teat in the pouch. There was no evidence that any of the crawlers actually observed was actively assisted by its mother.

At birth, the animals weighed about 750 mg or 0.0033 per cent of their mother's weight. One young one was accidentally detached from the teat when it was being measured at the age of 26 days. No amount of manipulation enabled it to get back to its food supply and it died. The sex of the young was determinable when they were from 14 to 20 days old, and they finally hopped out of their pouches at the end of about eight months.

Attested cases of unusually delayed birth are known to be caused when a female who loses her young and stops producing milk develops another, quiescent embryo. With a reserve to fall back on in the event of an accident, it looks as if the crawl to the pouch is not quite a hazardous method of reproduction as it looks.

Speeding the data from the spark chamber

IN breaking new ground, like that of the Brookhaven National Laboratory's recent discovery of the key omega-minus particle (*New Scientist*, Vol. 21, p. 523) the high-energy physicists are obliged to take hundreds of thousands of photographs of particle tracks with the various kinds of detector—particularly bubble and spark chambers —which they use to look at nuclear interactions. While a good deal of the calculation that follows an experiment can be performed on a computer, the whole business of data-handling is far from automatic as yet and involves much tedious preliminary scanning and measurement of the pictures. Methods of mechanising the processes are under development in all the major elementary particle laboratories, and this week at the European Organisation for Nuclear Research (CERN) the spark-chamber experts are gathering to discuss ways in which their equipment can be designed so that it feeds information directly into a computer without the intermediate step of photography.

Spark chambers, which have been in use since 1959, are one of the physicist's more recent additions to the range of particle detectors. Basically they consist of a series of parallel conducting plates mounted in a box full of gas. If a particle passes through the chamber it ionises the gas along its path so that when a high voltage is applied to alternate plates, sparks occur along the lines of gas ions, illuminating the particle tracks. At CERN currently about 27 per cent of all experiments involve spark chambers, compared with 45 per cent using bubble chambers. At present the normal procedure is to photograph the sparks, which must then be measured before the computer can do anything with the results.

Clearly, if spark chambers can be made which inform the computer directly they will save much time and increase the work capacity of the big accelerator laboratories considerably. Three methods by which this might be done are under investigation and will form the basis of the topics the physicists gathered at CERN are talking about.

One is to use a type of television camera, or "vidicon" tube, which stores the image of the spark tracks on a photocathode for a few milliseconds; while it remains it is scanned by an electron beam which produces electrical signals that can be recorded on magnetic tape in a mere ten microseconds. The tape is then fed into the computer. Its originators claim that their method allows from five to ten events to be recorded per accelerator pulse. American cosmic-ray physicists are particularly interested in this approach, which will probably be used in artificial satellites.

Secondly, there is the wire chamber which consists of criss-crossing arrays of fine wire grids with as many as 20 wires to the inch. Sparks between adjacent grids flip over the magnetic polarisation of a ferrite memory core; the locations of the reversed memory elements and hence of the spark tracks can then be found by an electronic read-out system which records its results on a magnetic or punched tape. Development has reached the point where particle tracks can be located to within less than 1 mm in milliseconds.

The third, filmless spark chamber is the only one that has so far actually been used in experiments—at CERN, Columbia University and Harwell. Sparks are located rather as if they were miniature earthquakes, only instead of using seismic recorders to find the source of the disturbance, it employs microphones placed at the edges of the plates. By comparing the times taken by the sound of the spark to reach each microphone, the position of the track can be found to within less than 1 mm. One great advantage of such "instant" results is that they enable researchers to find out what is happening during the course of an experiment and so make any modifications that may be necessary.

Plans for a technology ministry

THE concept of a Ministry of Industry and Technology, which would support development in that large area of private manufacturing industry not falling under the particular care of other departments, was explained by the Labour Party this week.

Labour has been evolving its science policy by exposing the proposals of its working groups to criticism by scientists, businessmen and social scientists at a series of private meetings in London and provincial centres. The latest of these, the sixth, was held at the weekend in London, presided over by Mr Richard Crossman, MP. Afterwards, Mr Crossman, supported by Professor P. M. S. Blackett, Lord Bowden and fellow MPs, outlined the trend of the discussions.

If Labour wins office, it intends, over a period of years, to increase government support for civil research and development in industry by an additional £50 million a year, as proposed by the Federation of British Industries. The Ministry of Industry and Technology would be the chief agency for this purpose. An enlarged National Research Development Corporation, with its terms of reference relaxed so that it can take greater risks, would be one of its aims. Prospects of profitability would be the chief test in deciding which ventures to back. Tho proposals would originate from industry itself and would not be imposed from above; the Labour Party believes that there are a lot of technological opportunities that are missed for want of capital.

The meeting evidently shied away from the idea that the Ministry of Aviation might form the basis of the new Ministry. The intention is to transfer individuals from Aviation and to bring in people from industry and the universities for full-time employment in the Ministry of Industry and Technology, for spells of two or three years. New arrangements about conditions and pensions would make the interchange between different fields more profitable for the individuals concerned.

As for its relationships with other departments, the new Ministry would carry out its work on technological development in the light of the aims indicated by the Ministry of Production—essentially a planning department for economic development, which would also draw up a manpower budget. The research councils would be brought back under the Lord President of the Council (the government is putting them under the Secretary of State for Education and Research next month). The Industrial Research and Development Agency recommended in the Trend report would not be set up.

A fire fountain from the new Icelandic volcano of Surtsey photographed from the sea on the night of 5 February. These fire fountains of huge glowing lava drops sometimes reach a height of 1000 ft. (J. E. Guest)

Contrasting performances in the same volcano

ON a recent return to Surtsey, the new Icelandic fissure-volcano, Dr A. T. J. Dollar, of Birkbeck College, London, and Mr J. E. Guest, of University College, London, added to their previous observations (see *New Scientist*, Vol. 20, p. 591) and took photographs from high and low flights across it and from a fishing boat standing within 300 ft of the north-west coast of the volcano, by day and night.

Particularly interesting was the increasing development on 5 February of gigantic jets of steam with dark lava blocks and ash roaring at intervals to over 1000 ft from two vents, adjacent to the nearby beach, and within about 50 ft of two other vents where periodic fountains of great glowing lava drops rose silently to as much as 1000 ft. This was especially striking, as all four vents were in same crater at the north-west end of the volcano. The co-existence and maintenance of such "phreatic" activity (here ascribable to sea water suddenly flashed into steam by contact with hot lava in a vent) with the constrasting fire-fountains, characteristic of "Strombolian" volcanic activity involving the periodic uprise of hot mobile lava under moderate gas pressure in a volcanic throat open to the atmosphere, calls for somewhat unusual conditions.

On Thursday, 30 January, mainly phreatic activity was clearly seen but the volcano was quiescent on 1 February, and held a veneer of snow until mid-afternoon on that day. At 1.10 p.m. GMT a slight earth-tremor was felt in the adjacent Island of Vestmannaeyjar and about 10.45 p.m. GMT strong electric discharges took place over and near the island, indicating that activity was resumed. From then onwards, with a falling barometer, activity steadily increased until 5 February after which heavy cloud obscured the volcano. Lightning flashes occurred at intervals in steam-ash jets near to where they shot from their respective vents, while other flashes took place in the main cloud to which the jets contributed and were seen less commonly between this cloud and the sea.

About 7 p.m. GMT a considerable

Notes and Comments *continued*

increase in general activity was marked by showers of lava blocks in the phreatic jets which exploded with loud cracking sounds as they neared the highest points of their trajectories, to reveal glowing interiors. At this time photographs of the lava fountains and adjacent phreatic clouds were made on infrared film in order to study heat distributions in them. Meanwhile hundreds of lava blocks, up to 12 ft in diameter, fell into the sea with a thudding sound, raising high white splashes reminiscent of diving gannets, or fell on the flanks of the cone.

Whenever fire-fountaining was intense the inner surface of the cone was showered with masses of red hot lava, some of which coalesced into an almost continuous sheet which moved downwards under gravity. Sulphurous gases and strong radiant heat were noticed particularly when flying over the fire-fountain in the crater.

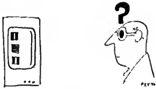
Wise to be cautious about colour television

NOW that the European broadcasting experts have failed to agree on the choice of transmission system for colour television, the British Postmaster General has an awkward decision to make. Should he give the go-ahead to BBC colour broadcasting, and take the risk that the other European countries will standardise on a different system, or should he wait indefinitely for agreement?

In truth, the rival methods of transmitting a colour television signal — American, French and German—appear to differ only marginally in performance and in the cost of the necessary equipment. However, they are sufficiently different in technique to have a radical effect on the design of receiver circuitry, and if the standard were not uniform throughout Europe exports of equipment as well as exports of programmes could be seriously affected.

On the other hand, it can be argued that a good system exists, that no radically cheaper or more elegant display device for colour pictures is in sight to replace the "shadow-mask" tube, and that Britain might as well get on with the job of providing, at least for her wealthier citizens, television programmes in full colour.

On the whole, it may be better to wait. Colour television is an expensive business, not only for the viewer but also for the broadcasters. If American experience over the past ten years is any guide, there will not be a big rush to buy receivers and there may be a good many years of flirtation before colour television makes a major contribution to the nation's entertainment and enlightenment. Accordingly, the benefits of an early, unilateral decision on the transmission system are probably small compared with the inconvenience of making the wrong choice. Only if the Postmaster General has grounds for confidence that a British initiative will induce the rest of Europe to follow with the same system should he take the plunge.



Beryllium makes a comeback—in a missile

THE announcement of a contract worth more than $2 million, granted to the Brush Beryllium Company, Cleveland, Ohio, for the manufacture of "spacers" for the latest model of the Minuteman missile, re-establishes resoundingly this vexatious metal's claim to an important role in engineering. The spacer is a load-bearing component and connects the re-entry section of the missile with the guidance and control compartment. Previous spacers have been made of aluminium, and the change is claimed to provide a saving in weight of more than 50 per cent.

Beryllium is a remarkable metal—on at least two different counts. In Britain it is probably thought of chiefly as the metal that was abandoned by the Atomic Energy Authority early in 1962, after a brilliant future had been predicted, on the basis of its very low neutron absorption; the snags at that time were its brittleness, its tendency to crack up on cooling from high temperatures, and the difficulties of fabricating it.

Leaving aside its properties in a nuclear reactor, however, it remains the lightest of the practical metals—two-thirds as dense as aluminium, and more rigid, weight for weight, than titanium, high-tensile steel or aluminium alloys. Its high melting point (nearly 1300°C) and specific heat complete in all essentials the picture of the metal that was chosen for the heat shields of Mercury spacecraft.

Behind this new contract lies a story of major advances in the fabrication of beryllium, by techniques worked out by Brush Beryllium and the Ladish Company of Cudahy, Ohio. The sequence includes "ring rolling" a (novel rolling technique developed specifically to fashion the spacer), chemical milling for weight removal, an automatic drilling process that exercises very tight control over the cut, and a low-temperature brazing stage using zinc alloy. All these operations are carried out on a thick-walled cylinder of beryllium that is machined from a hot-pressed block of the metal.

The weight of the latest version of the Minuteman component, a shallow cylinder about a yard across reinforced by four "backbones" of the same sheet metal, is 17 lb, an improvement of 30 per cent over the first design objective for beryllium.

Computer in the classroom

IT is one thing to pay lip service to the modern idiom, quite another to act upon it. The Royal Liberty School, at Romford, Essex, has not only accepted the idea of the computer, it is going to purchase one. By its planned use the school proposes to disseminate a knowledge of tomorrow's arithmetic among most of the selective secondary schools in the district.

The plan is to teach programming and the use of the computer not only to sixth-form mathematicians but to arts sixth formers as well. As soon as possible, all the pupils in the school will be brought into the project at the fifth-form ordinary level GCE stage. The cost will be of the order of £20 000, a substantial consideration for one school. Obviously a great deal of the work can be done away from the computer so the problem of using it fully and economically must be faced. At this stage four more schools have accepted invitations to take part in the project. At its final development it is hoped eight schools will be involved. A library and record room will be set up at the Royal Liberty School from which the scheme will be administered.

At five hours per school the computer will be adequately used. Vacation, weekend and other times may also be used for courses for teachers and other students. Once the scheme is under way it should mushroom with impressive rapidity. This training of other teachers answers one problem implicit in such schemes. Few teachers have first hand experience of computer work and by the nature of their job they are not likely to get it. The Royal Liberty School is particularly fortunate in having no fewer than five mathematics teachers with some experience, including one acknowledged expert. It thus provides a perfect atmosphere in which the idea can flourish.

It is hoped to raise the necessary finance by approaches to local industry and to the local authorities. From the same sources will come many of the administrative and business problems to be programmed and evaluated. One of the fascinating aspects of the plan is that an adept 16 year old may be posed with the administrative problems of his own locality and may very well come up with the right answers.

Artificial insemination to to boost pig industry

THERE is no doubt that we could quickly transform the pig industry by the widespread use of artificial insemination. That is the opinion of Sir John Hammond, the distinguished agricultural scientist. He discussed this possibility recently in *Agriculture* (Vol. 71, No. 2, p. 52). Our dairy cattle today are striking testimony to how effective AI can be, whereas our pigs are now in much the same condition as dairy cattle in pre-war days before it was introduced. Most of them are bred in small herds which cannot afford to keep a good progeny or performance-tested boar, but the pig industry does have the advantage that while, when AI was introduced for cattle, there were few good bulls to be had, large numbers of suitable boars are now becoming available.

As most small commercial pig breeders keep sows which they have bred themselves, regular use of a progeny-tested boar will give 50 per cent "good blood" in the first generation, and this proportion will build up rapidly in successive generations which, in pigs, come at shorter intervals than in cattle. A proposal to establish "accredited herds" consisting only of progeny-tested boars and sows, may eventually result in enough boars to meet the demand, and if these boars are used for AI, improvement would be more rapid.

There are several technical and economic differences between AI in pigs and in cattle which need to be taken into account. The conception rate in pigs has often been rather low, but this has mainly been due to insemination at the wrong time, a fault which can be rectified by careful instruction of the inseminators. Furthermore, boar sperm has so far only been kept fertile outside the body for about twenty-four hours, whereas bull sperm can last for three days. Boar sperm cannot be preserved by deep freezing. Nor can it be diluted as much as bull sperm. At least 30 c.c. is needed for insemination (compared to 1 c.c. in cows). This, and the limitation on storage, keeps the number of sows which can be inseminated from one boar to 2000 in theory and about 500 in practice, though this is mitigated by the fact that boars are less expensive to keep than bulls.

As the working expenses of an AI station consist of travelling costs and the inseminators' time, sites of AI stations should be carefully chosen. The centre of a thickly populated area is the best choice, and some limit is usually placed on the radius of operations. For cows this is generally 20 miles, but a smaller radius may be necessary for pigs. Although it has been argued that costs could be cut by having the same operator to inseminate cows and sows, it seems better to have specialised inseminators for the two different species, and perhaps to save expenses by such devices as regulating the time of weaning in sows so that several come into season at the same time. Further developments in this field will depend partly on any improvements in technique resulting from research now in progress, but also on the extent to which pig producers can see results in terms of livestock improvement. If this can be assured (as it will be if top-quality progeny-tested boars are made available for AI) the prospects for using AI in the pig industry are distinctly encouraging.

A little "Science Centre" for London?

WHEN the Royal Society announced last year that it was planning to move from Burlington House to Carlton House Terrace, it stirred up once again the problem of the accommodation of the other British scientific learned societies. This decision has been regarded as "the last nail in the coffin" of the Science Centre which was at one time envisaged for housing together most of the scientific societies. In truth the chances of creating such a centre seem to have got steadily more remote after the failure of the various parties to seize the initiative so imaginatively pioneered by Sir Robert Robinson when he was President of the Royal Society.

It is generally agreed that the societies are interested in accommodation in London for three purposes. The first, for national meetings, is moderately well provided for, although it is not easy to find a place for a meeting of 500 people for three days with good catering facilities. The second is for large international congresses involving at least 3000 people. There is no provision at all in this category, so that London is now almost unique among the large cities of the world in this respect. Finally, the societies need good offices for the administration of journals and the many other facilities, such as libraries, demanded by their members.

In so far as offices are concerned, most of the large societies are either looked after by the government in Burlington House or elsewhere or are now able to make their own arrangements, expensive though they may be. There remains, however, a group of smaller societies who are not at present adequately housed. They realise the advantages of cooperating together so that they may have good offices, shared committee rooms and modern office equipment. For some time this group has been looking at various schemes in vain, but recently the prospects of a successful outcome have greatly improved.

A company has been formed with the object of providing a building for various organisations including the scientific societies. A developer has agreed to operate on a non-profit basis so that rents can be kept to the minimum. It is hoped that the building will be erected in two to four years at a site in London which will be reasonably convenient for all.

Revaluing the engineer's contribution to society

THE great pioneers of engineering worked by the light of their experience and intuition, and science played little part in their design, Sir Harold Hartley, chairman of the Central Electricity Generating Board, told his audience in the first Maurice Lubbock Memorial Lecture at Oxford last week. They had, he went on, that intuitive sense of rightness that has guided engineers since they designed aqueducts—and which, as the Feilden report made clear last July, is still the prime arbiter in the art of engineering design.

Sir Harold spoke the day after the Department of Scientific and Industrial Research had called a press conference to report progress on implementing the Feilden report's recommendations; and progress there has certainly been.

A great deal of it is to do with the whipping up of public interest in the problems of the engineer—indeed, in the existence of the engineer and his contribution to national well-being—to which end the Department of Scientific and Industrial Research can point to considerable activity. Many television programmes are planned, by both BBC and ITV, for the coming months; a Rank film, "Look at Life", to be released on 29 March, extols the advantages of an engineering career; and a series of regional conferences, organised by the Federation of British Industries, in which Mr G. B. R. Feilden, and his committee will participate, are planned for the spring, to be accompanied by a small exhibition entitled "Good Design Pays".

There is a small core of practical progress, too. One example is the matter of data sheets, an idea that was highly praised by the report, which recommended that the professional institutions be encouraged to follow the example of the Royal Aeronautical Society in issuing them. The DSIR announced that it has made a grant of

Notes and Comments *continued*

£25 000 to finance a pilot scheme of the Institution of Mechanical Engineers to prepare and issue "design memoranda" over the next two years. The Institution has organised three panels to prepare draft sheets.

Again, in the matter of encouraging greater productivity and efficiency in the drawing office, a fact-finding subcommittee has been set up by the National Engineering Laboratory, with members drawn from the machine tool and electronics industries, universities and other national laboratories; about 30 firms have been visited in the past couple of months.

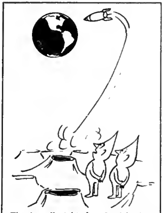
One-third of the entire contribution of the manufacturing industries to Britain's gross national product comes from her engineering firms; and these firms account for nearly half of the nation's exports. (In fact, these figures greatly understate the position, for engineering contributes importantly to every other industry's activities.) The goal of every engineer (or "chartered engineer", as he may soon be called) should be the truly economic design of his product. It is the best formula for commercial success—and his best defence against the customer who thinks the value of his purchase is proportional to its weight.

A shot in the arm for oceanography

IT seems a little surprising that the placing by the Admiralty of an order for three combined survey and oceanographical ships should have been announced merely by the shipyard concerned, without a formal statement from the Admiralty itself. For the orders presage a change in the balance of work undertaken by the Admiralty's surveying service, and a considerable increase in British research in the oceanographic field.

Although a small amount of oceanographic work is already carried out by RN survey ships, none was designed for this work. Indeed the only British ship of this type designed from the start for surveying work is the postwar-built *Vidal*. Of the other deep-sea ships (as distinct from the three new little inshore craft of the *Egeria* class), four were laid down as frigates during the war and converted immediately after the war while still under construction; the remaining one is a prewar vessel, built as a minesweeper.

Britain has one specialised oceanographic ship. This is the *Discovery* of the National Institute of Oceanography, completed a year or so ago. Thus when the three new Admiralty ships come into service during the second half of next year, the number of British ships designed for this work will go up from one to four. The new ships will not represent any significant addition to the numbers of survey vessels in service, as existing vessels will be taken out of service as they are completed. But their arrival on the ocean will be the signal for a much larger Admiralty participation in oceanographic work.



They're all right, but I wish they wouldn't refer to us as "a chip off the old block"!

Study in depth of the urban scene

IN a statement it has issued calling for the creation of a new research council, the Royal Institute of British Architects avows that its field of interest is nothing less than the "built environment" as a whole. It had been clear for some time that the various activities and disciplines concerned in creating a building or implementing a complete building programme—technological, social, aesthetic and administrative—fail to form a coherent unity in Britain. The technological bodies alone have a communication problem great enough to warrant the joint meeting that took place recently of the Institutions of Civil, Mechanical, Electrical and Structural Engineers and the RIBA, aimed at the formation of a forum to be called the Joint Building Group. There is also brought the recent news that Dr Thomas Prosser has been chosen for the new National Building Agency, a body whose objects are to popularise the use of industrialised building techniques and to attempt to replace the present multitude of small contracts, for which these methods are impracticable, by a small number of large orders to which prefabrication, so widespread in some other countries, can be usefully applied.

It seems that, as one attempt at organisation succeeds another, the picture merely becomes more confused. The RIBA evidently felt that somebody had to provide a lead. More important, it saw the broad perspective of the "built environment" facing a positive threat. The Trend Report recommended that the Department of Scientific and Industrial Research's Building Research Station should become part of the proposed Industrial Research and Development Agency, and the Woodbine Parish Report had asked for a Building Research and Information Association. The Heyworth Committee for Social Studies had asked the RIBA to comment on its ideas on social studies in relation to the "built environment", and the Chartered Surveyors—together with a number of other professional bodies—had proposed a Land Use Research Trust, to study the efficient partitioning of the country's land area in the face of growing wealth and population.

All of these efforts, the Royal Institute considers, can lead at best to only partial solutions of what is essentially a single, although very complex, problem—comparable with those of medicine and agriculture, which have their own research councils. Like them, the new research council should be the responsibility of a Minister, and the Secretary of State for Education is suggested. The Council would include among its members "a substantial proportion of national figures" not belonging specifically to any one field. Whom would it include among its researchers? The RIBA recognises that to be a problem.

A field in which a real movement towards unity is occurring is that of building regulations. Until now new buildings have had to conform to regulations—as regards drainage, fire resistance, sound insulation, structural stability and so on—enforced in some cases by acts of Parliament and in others by local authorities. The latter have been guided by a system of model by-laws, the responsibility of the Ministry of Housing, but nevertheless standards have varied from place to place, to the inconvenience of builders. A few years ago the Ministry drew up a draft national system of regulations, and by the end of the following year the comments of all interested bodies had been received.

The next stage was concluded last week with the appearance of the first report of the Building Regulations Advisory Committee. The views of this committee on the form and content of the national regulations have been accepted by Mr Geoffrey Rippon, the Minister of Public Building and Works, whose responsibility the new regulations will become. However, these regulations, when they come into action, will serve only to remove the diversity of local by-laws; the committee envisages, ultimately, the complete rationalisation of all the relevant legislation.

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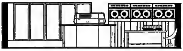

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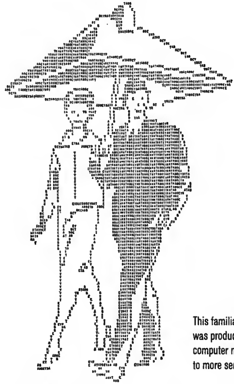

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Can cross-Channel hovercraft pay?

Hovercraft engineers argue that a suitable craft could carry 200 passengers and 30 cars from Dover to Calais in 22 minutes, and do so at a profit if it had a sufficient share of the traffic. Yet this may not be a good route on which to demonstrate the possibilities

by David Fishlock

LAST week Westland Aircraft, a prime mover in the development of hovercraft, published an ambitious scheme for a ferry service across the English Channel, based on a 150-ton hovercraft, the SR.N4, that is still on the drawing board. The 75-page report that describes the scheme takes as its starting point the growth of cross-Channel traffic (Figure 1) predicted in a White Paper published by the Ministry of Transport last September ("Proposals for a Fixed Channel Link", Cmnd 2137). Its main conclusion is that a "fairly modest" fleet of these big hovercraft could be expected to cope adequately with the anticipated growth in traffic for the next twenty years or so—and that the service would make a handsome profit.

On the face of it, the Westland engineers have made out a compelling case. They are asking that, between now and 1985, someone—the state, presumably—should invest £34 million in capital costs and £106 million in running costs to establish a service that would earn £192 million over that period. But let us look more closely at the scheme we are offered.

Briefly, Westland has based its scheme on the projected SR.N4, a Hovercraft 128 ft in length, having an all-up weight of 150-165 tons and powered by 10 000-15 000 h.p. engines. Such a craft is needed to cope with the highly variable sea conditions of the Channel, analysis of which shows that, for 90 per cent of the time, the waves are 4-5 ft or less and associated with wind speeds of 15-20 knots, for 5 per cent of the time the waves reach 6-8 ft and the winds 25-30 knots, and one one or two days a year, the waves reach 13 ft and the wind speeds 40-45 knots. The SR.N4 has to be capable of operating at 70 knots for most of the time, at 40-50 knots in seas of 6-8 ft, and at 25-30 knots in seas of 13 ft.

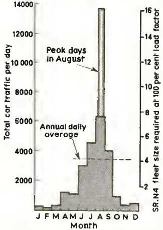


FIGURE 1. *Total cross-Channel car traffic from 1985 on, predicted in the Ministry of Transport's White Paper, and the number of hovercraft needed to meet this demand. Note that for all but a few days in August, a fleet of less than half the total maximum is adequate.*

It is being designed specifically as a passenger/car ferry, for a load of 60 to 75 tons, with a typical range of 190 miles and an endurance of 2.6 hours. Its main engines will be four Bristol Siddeley Proteus gas turbines, rated at 3400 s.h.p. apiece, supplemented by two Rover gas turbines for auxiliary power. Several variants are visualised, but typically the SR.N4 would carry 566 seated passengers, or 228 passengers and 27-32 motor cars, or 50 passengers, a dozen motor cars and two lorries.

Such a craft would take only 22 minutes to make the crossing from Dover to Calais, and only 75 minutes to cross from Southampton to Cherbourg. As it would be fitted with the latest advance in hovercraft engineering, the flexible skirt (which, in the SR.N3, a 27-ton craft, which recently began sea trials, consists of a 4 ft-deep skirt of rubberised plastic). This skirt allows the hovercraft to ride over much greater obstacles, and would make the craft fully amphibious and hence independent of the tides.

To implement the cross-Channel service, terminals ("hoverports") would be needed; where the hovercraft could be turned around quickly and passengers and vehicles handled smoothly. The Westland engineers have envisaged a comparatively straightforward layout, covering about 30 acres, costing about £2 million (see Figure 2). It would have a large concrete apron that joins the sea by way of two slipways, together with customs, immigration arrangements, car park, fuel storage and the usual concomitants of a terminal of this nature.

One other major unit completes the scheme: a maintenance base for the hovercraft. A suitable base, equipped with two hangers, an apron and slipway, and the means to lift a "dead" hovercraft from the water, would need about 10 acres and its cost is put at £1.5 million.

A ferry service based on this scheme would be in competition with several other forms of transport, even if nothing radically new emerges in the next 20 years. Westland simply tries to demonstrate how, given the predicted increase in passenger traffic across the Channel, a profit could be made using hovercraft. There is good reason at this stage, however, to believe that, if a profit can be made by using hovercraft, a bigger profit (or cheaper fares) could be secured by other means.

To start with, each SR.N4 will cost, it is estimated, £1.15 million to build and its working life is put by the firm at ten years. For comparison, a conventional British Railways ferry costs about £800 000, and is amortised over 25 or 30 years. The ship is slower, but of higher capacity, and its overall daily capacity will be about two-thirds that of the hovercraft.

But this is by no means the whole story, for the hovercraft need special terminals, at £2 million a time, whereas the ports already exist (Harwich, Folkstone, Dover, Newhaven and Southampton) for conventional ferries. To show how little land will be required for hoverports, the Westland report compares a plan view of Dover harbour with one of the proposed hoverports on the same scale. But, while the one is composed chiefly of water, the other needs 30 acres of land. Nor is there much of a technical case to be made for the experience to be gained from building hoverports, which are perfectly ordinary in concept.

There is another aspect to the problem, too. Figure 1, which gives the predicted increase in cross-Channel traffic, also gives the pattern of demand, which is highly seasonal. Westland proposes that, in order to meet the peak August daily traffic of 13 500 cars, the service will need at least 16 SR.N2s, although the average August demand could be accommodated with six or eight craft and the winter demand with a single craft. To lay up an expensive vessel for long stretches of the year is good business only for its manufacturer. On the other hand, if you are going to lose money to cater for a special public need, namely, the peak demand—and here we have an analogous situation with many of Britain's railway lines—it is not good business to choose a more elaborate way of losing money than is necessary.

To summarise the case against the cross-Channel hovercraft, then, it appears that the traffic on this route is too "peaky" in demand, and the distance too short in relation to the capital outlay, to warrant its implementation at public expense. (A somewhat better case might be made out for the Irish Sea route, for which the crossing is about 120 miles.)

Then there is the hydrofoil, a competitor which is developing at much the same pace as the hovercraft. A 1000-ton version of this high-speed craft, which is lifted out of the water on stilts, would have a range of 500-800 miles and capacity for 1500 passengers (though not, it is true, for motor cars). It is worth noting that where high-speed ferry services have been adopted—on the Swiss lakes, between Finland and Sweden, in several places in Italy, on Long Island and Puget Sounds in the USA, and very soon between the Hawaii Islands and between the Channel Islands and St. Malo—the craft chosen has been the hydrofoil, not the hovercraft.

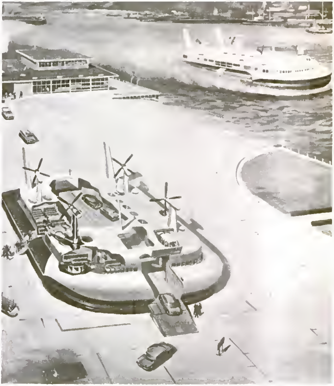


FIGURE 2. *Artist's impression of the proposed Westland "hoverport" and the SR.N4. The concrete apron has two slipways at 90 degrees to each other, to allow pilots to choose the approach best suited to the wind direction.*

Lest this article may seem to amount to an indictment of the hovercraft, I want to make it clear that it is the application, not the invention, that I am criticising. An argument in favour of a cross-Channel hovercraft might be the prestige that could accrue from the first full-scale application of this British development. But there is much to be lost, too, by investing in a spectacular application that is not founded on the best possible commercial principles.

The hovercraft, as Kenneth Hall of Hovercraft Development Limited showed in his article (*New Scientist*, Vol. 21, p. 76) has many potential applications. Even so, few of them, other than the military ones, are likely to be immediately appropriate to Britain. (Later, of course, there will be the hovertrain.) If the nation's money is to be sunk in a scheme that will attract prestige and hovercraft orders to Britain, it should be one that exploits those unique characteristics of the craft that enable it to traverse otherwise difficult territory — mud, quicksand, swamp, marsh, desert. Why not a "longhaul" cattle-lift scheme for the Argentine or sheep-lift for Australia, that gets the meat to market without the costly attrition of the herd that the farmer normally faces?

Pesticides and health

In Britain the concentration of chlorinated hydrocarbons in human tissue is still relatively low but in other countries it has risen to alarming levels. Responsibilities for safeguarding the public have still to be defined

by John Hillaby

ALTHOUGH conservation remains one of the most talked about and least practised subjects of the pesticidal 1960s, there are hopes that an authentic Ombudsman has risen above the ranks of the wailers, the well-wishers and the voluntary invigilators. He is Walter Scott, the new scientific director of the Universities Federation for Animal Welfare. At a meeting in London last week, Major Scott related, unemotionally, what he had learnt about chemical poisoning of man and animals from recent and all-too-fragmentary bits of research in half a dozen countries. From this gruesome material he extracted a number of uncomfortable conclusions, the most forceful of which was that, by chain reactions, the indiscriminate use of pesticides may affect the health of large numbers of people —in Major Scott's ironic phrase, may "ultimately adjust any awkward balances of the human population".

Those who are tempted to shrug off this jeremiad for a variety of subjective reasons—should reflect, first, that Major Scott is a veterinary surgeon who worked for some years for a firm of chemical manufacturers and that, secondly, that there are marked efforts to dampen if not suppress information relating to human casualties.

In Africa they have been obscurely reported from almost every programme in which dieldrin has been applied for any length of time in the form of indoor sprays. Casualties have also occurred overseas as a result of animal-spraying ventures and particularly those associated with tsetse-fly control.

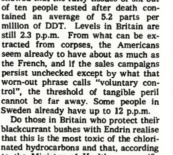
The onset of symptoms in animals poisoned by chlorinated hydrocarbons may vary from a few minutes to days, depending on the compounds used and the dose applied or ingested. Symptoms get progressively more severe, beginning with apprehension followed by hyperaesthesia, muscular spasm, agitation, lack of coordination, abnormal postures, convulsions, mania, coma and death.

All the chlorinated hydrocarbons are insoluble in water but soluble in fat. They can penetrate intact skin when applied in the form of an oily solution or an emulsion. Dieldrin may be absorbed as a dry powder. After absorption they are stored in the body fat. Some compounds may persist in fatty tissues for months. A major route of excretion in the case of DDT is via the milk.

Recent investigations in France showed that the fatty tissues of six out of ten people tested after death contained an average of 5.2 parts per million of DDT. Levels in Britain are still 2.3 p.p.m. From what can be extracted from corpses, the Americans seem already to have about as much as the French, and if the sales campaigns persist unchecked except by what that worn-out phrase calls "voluntary control", the threshold of tangible peril cannot be far away. Some people in Sweden already have up to 12 p.p.m.

Do those in Britain who protect their blackcurrant bushes with Endrin realise that this is the most toxic of the chlorinated hydrocarbons and that, according to the Ministry of Health, no specific chemical tests for Endrin poisoning exist? Nor are there any known antidotes, although barbiturates may help in controlling the convulsions.

The situation today is distinctly gloomy. A report from the bird protectionists is expected to show that more species and larger number of casualties from chemical contaminants have been found than ever before. The latest news on record is that the breeding of the golden eagle has shown a catastrophic drop in fertility.



Insecticides used in sheep dip are believed to be largely responsible for a drop of more than half in the number of golden eagles breeding in Scotland. The birds ingest the poisons from carrion. This is the conclusion of Dr J. D. Lockie and Dr D. A. Rotcliffe of the Nature Conservancy who state in the current issue of British Birds *that a still greater decline is likely if the use of pesticides continues unchecked.*

But is this verifiable decline in bird life completely relevant? Many thousands of people believe it is. Ignoring for the moment the humanitarian, aesthetic and ecological aspects of the problem, Major Scott thinks that the fact that some chemicals upset the breeding of birds and the hatching of eggs should be regarded in the same light as the warning given by the collapse of the miner's canary.

According to the recent Agricultural Research Council's Committee report on toxic chemicals there are "no major gaps" in research at the present time. The government's big interdepartmental report is still to come. We may hope it will not follow the pattern of its predecessors in seeking reasons rather than remedies. The analogy so far has been with a band of firemen who stand round a blaze, speculating about the cause of the conflagration before attempting to put it out.

It is surely not without significance that the New Zealand government has recently banned the use of 130 brands of chemicals on livestock. The banned products include DDT, Aldrin, and Dieldrin, together with a large number of others which are freely available to farmers in Britain.

Buried inside the report from the Agricultural Research Council, which was compiled by twelve scientific civil servants and two independent scientists, there is this sentence: "We are not concerned with the administrative control of pesticides which is fully dealt with by other authorities." Which authorities, and how fully are they dealing with it? The regulations and recommendations of the Ministry of Agriculture, Fisheries and Food would, in many cases, be completely adequate but so far the Ministry has not seen fit to enforce them.

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The migrant scientist

There has always been a magnet for men of learning. Some centuries ago it was Italy, later Britain and today the United States. But there is now a danger that land in Asia and Africa may go uncultivated because of American efforts to put a man on the Moon

by Lord Bowden
Principal, Manchester College of Science & Technology

IN the last two weeks, *New Scientist* has told of the revolution in nuclear physics represented by the development of the theory of unitary symmetry and the discovery of the omega-minus particle. Fundamental contributions have been made in this work by Professor Abdus Salam, who came to England from Pakistan, and Dr Y. Ne'eman, who joined him from Jerusalem. They developed ideas of Professor Ohnuki of Japan and collaborated with Professor Gell-Mann who was visiting London from California. What better illustration can we have of the international character of science? And what better demonstration, that Britain is gaining scientists as well as losing them?

Dramatic stories have been told of mediaeval students who wandered about all over Europe seeking the most famous scholars of their generation. Abelard in Paris attracted an enormous number of men from England and the great medical and law schools of Italy were the familiar haunts of scholars from all over the civilised world.

Nowadays theologians are neither so numerous nor so mobile as they were four or five hundred years ago. Furthermore, Europe has lost the unifying effect of a single, all-powerful church. Today it is science which is international and it is the scientists who wander about the world in search of opportunities for learning and teaching. But although the tradition of academic migration is ancient, its character has changed in the last few years.

A hundred or so years ago, Britain's educational machine was appallingly inadequate; Matthew Arnold remarked that the only countries which had systems like ours were Rome and Austria. He complained that there was:

> ". . . the same absence of system, the same powerlessness and indifference of the State, the same independence of single institutions, the same abuses, the same confusion and the same lack of co-ordination, the same extravagances and the same poverty of result. Unlike in other things, Austria, Rome and England are alike in that their civil organisations all deny the right of mind and reason to rule human affairs. In Rome that right is sacrificed in the name of religion, in Austria in the name of loyalty; and in England in the name of liberty."

Even the few who went to school learned little or nothing of any use to them. *Nature* complained a hundred years ago that a great deal of nonsense, both pernicious and boring, was taught in schools. Children learned the names of the children of Queen Anne who died in infancy but not how it came about that the sun rises in the east and sets in the west. Lyon Playfair pointed out that:

> "A thousand men perish yearly in our coal mines, yet no schoolmaster tells our poor miners the nature of the explosive gas that scorches him or the after-damp that chokes him . . . Our countrymen perish by the hundreds of thousands and sicken grievously through pure ignorance of the laws of health which were never imparted to them at school. The age of miracles is past and our large faith in our little doings will not remove mountains."

Playfair added that one of the mountains was what we now call delinquency. He thought that children should learn science and one of the first lessons a child must learn from it was not to trust to authority but to demand proof. Education in science gave discipline and courage to thought. The existing system was ignoble because it set the pupil out into the world "in gross ignorance of everything he is to do in it". How true, how old, and yet how new!

The only places where science was being taught to children or to craftsmen a hundred years ago were Dissenters' Academies and Mechanics' Institutes, which were poverty-stricken, despised, miserably housed and totally ignored and neglected by the government.

Despite the fact that she was the most illiterate nation in Europe, England was the wealthiest country in the world and enterprising young men came from all parts of Europe. Much of the prosperity of Lancashire was founded by the efforts of such people as Henry Simon and Hans Renold, both of whom had been educated in the technical universities of Europe and came here to make their fortunes and establish great industries. When the first chemical plant was built in Widnes 80 or 90 years ago, even *The Times* was moved to complain that it was a national disgrace that all the chief scientists had had to be imported from abroad and that Britain could produce none of her own.

For many years engineers were the most valuable of all Swiss exports. The great technical university of Zurich educated the men who designed and built the most important bridges on the railways and roads in America in the 19th century; the same university exported Einstein to Princeton. Few countries were seriously worried about the loss of young men to a country in which their opportunities were obviously greater. Bismarck and his Kaiser were anxious to keep their German engineers at home; Britain exported her graduates—most of whom were classicists—to every country in the world.

But Britain guarded the secrets of industry with extraordinary tenacity and, until long after Queen Victoria came to the throne, skilled craftsmen who tried to emigrate and establish competitive industries in America were likely to be hanged if they were caught. The textile trade in America was started by a craftsman who had been apprenticed to Crompton before he went abroad. No one was worried when Priestley went; he was only a chemist (perhaps the best in the world) on the staff of a Dissenters' Academy in Warrington.

Nowadays great nations realise that national prestige as well as national prosperity are in the hands of their scientists and engineers. A scientist is more important as a source of potential income than the most highly trained craftsman. He is much more expensive to produce and completely free to emigrate.

The movement of scientists in search of better pay and conditions and prospects has much in common with the migration which is driving people from the north-east of England to London, or from one part of the American continent to the other. This year 55 000 people are emigrating from Britain with assisted passages to Australia. Most of us are glad to maintain the tradition which provided some of the most energetic and thriving inhabitants of the new world in the last century.

People have always moved about and they will undoubtedly do so in the future, but while they are leaving these overcrowded islands for the great open spaces of Australia, the great open spaces of the Highlands of Scotland are losing people to the great overcrowded cities of England and Scotland.

In England, small universities lose their staff to Oxford and Cambridge and London, but the situation is not yet as critical as it is in America, where people are traditionally more mobile than they are here and where men do not usually stay to do postgraduate research in the university where they took their first degree. We have the Atlantic ocean between our universities and the Massachusetts Institute of Technology. Small American colleges are less well protected; good men are under constant pressure to leave small universities for big ones. They may become more productive scholars, but what is to happen to the students they leave behind? Many American university administrators are very worried men.

It is striking, in retrospect, to realise that the intense development of pure science in America had hardly begun 50 years ago, and that in the form which we know it American scientific research is almost entirely the creation of the last couple of decades. For many years America was content to prosper by developing manufacturing processes which depended upon the fundamental science of Europe. Suggestions that pure research should be done in the United States were vigorously resisted by some members of the Congress when they debated the Smithsonian bequest.

After the end of the last war, Vannevar Bush, who had been scientific adviser to President Roosevelt, wrote a most remarkable essay called *Science—The Endless Frontier*. He showed how his country had relied almost entirely on Europe for innovations in pure science and that now the nation had come of age and was the wealthiest in the world she could not remain parasitic on what was then a poverty-stricken Europe desperately struggling to recover from the aftermath of the war. As a matter of national policy, the United States had to attempt to take the lead in pure science, for it was upon new scientific ideas that the growth of her industries must ultimately depend.

I happened to be there at the time and I well remember discussing the implications of this document with the Presidents of some American universities. They knew how much USA had depended on European scientists. Almost every member of the theoretical physics group in Los Alamos was either an immigrant or the son of an immigrant; almost all their most competent nuclear physicists had been driven out of Germany by Hitler. The American universities deliberately decided to go to Europe to buy the best scientists in the world. I remember asking them how many men they must bring to a new continent if they were to establish a school which would be viable in its new surroundings. The "brain drain" we complain of from Britain today is as nothing compared to the brain drain which Hitler produced in Germany. America has profited from both.

I think the migration of scientists affects the underdeveloped countries most seriously. They seem to be losing their native sons as soon as they graduate. For example, far too many graduates of the University of Formosa have been lost to the USA; they go there with postgraduate scholarships to widen their experience and there they stay. This university, like many others in the poorer countries, finds it extremely hard to grow despite all the money which has been pumped into it over the last decade. What is far worse, its graduates have little or no effect in developing the economy of their own country. The same sort of thing seems to be happening in Malaysia, in India and Africa. Of 15 men who graduated this last year in engineering in the new University of Kumasi in Ghana, 14 are now abroad. They have gone in search of further postgraduate experience, as is only right and proper, but I wonder how many will ever go home again. No single Ghanaian engineer is working on the Volta River Project at this moment, yet this must be one of the most important and exciting pieces of engineering which will ever be undertaken in Ghana and it could provide Ghanaians with experience they are unlikely to get anywhere else in the world.

Most of the poorer countries find it extremely hard to persuade their scholars, engineers and scientists to go back and live among primitive peoples and help them to raise their standard of living by the simplest applications of science and technology. The graduates have escaped from the jungle or the backwoods, and they want to work in nice clean air-conditioned offices.

Who is to blame these young men for emigrating? They want to learn the best the modern world can teach them; few universities seem to expect their students to have any sense of obligation to the society which provided them with their opportunities. It seems to be enough that they are

The migrant scientist *continued*

members of the supra-national world of science, but are we sure? Do these young men owe nothing to their poverty-stricken countrymen? It may matter little or nothing where a piece of fundamental research is done, if its results become universally known, but the prosperity of society and the standards of living of both wealthy and primitive societies depend almost entirely on the results of applied research and modern technology, and this work must be done on the spot, in the backwoods if necessary, in conditions of discomfort—even of danger—far from the amenities of a modern laboratory.

What is a scientist's duty towards his neighbour? Is it, or should it be, in conflict with his duty to the world of scholarship?

In this vast migration Britain is a transit camp and we both gain and lose. It is notorious that British hospitals, and the whole National Health Service, would break down were we deprived of the services of the doctors from foreign countries such as India. These men are desperately needed at home in their own countries, but we want them here, and we make it worth their while to stay.

Transient visitors to Britain from overseas are coming in numbers which are large enough to distort the whole pattern of English university education. This is particularly true in departments such as those of civil engineering and textiles, whose research is sometimes dominated by foreign students. For example, there are 200 undergraduates in the new Civil Engineering Building of the Faculty of Technology in Manchester; there are seven research students from overseas and only two Englishmen in the postgraduate school. The Civil Engineering Department in the Faculty of Science in Manchester has six foreign research students and no British students at all. Imperial College, which houses much the largest postgraduate school of civil engineering in Britain, has about 200 undergraduates, 31 foreign research students and only 3 British research students. In their diploma course there are 70 foreign students and only 45 British students.

These foreign students are very welcome here, but it is alarming to find how few British students join them. I wonder whether the improvement in the productivity of British civil engineering industry—upon which so much depends—will be made by Englishmen who have learnt their trade here, by Englishmen who have gone abroad to study, or by foreigners who have come here to study and have then stayed here.

If the foreigners all go home Britain will be in a parlous state; if none of them go home the vast investment which has been made to build up schools of civil engineering in the underdeveloped countries will do nothing to help the poverty-stricken people who have paid for it.

It is impossible to compare the merits of the scientists who come to Britain with the merits of the scientists who leave. It may well be that the arrivals are less well educated than some of the men we lose, though he would be a brave man who asserted that they had less intrinsic ability; my own observation suggests that the men who come here, able or not, are more missed by the countries from which they come than those who leave our shores are missed by us.

Engineering, science, technology and medicine all the world over are profoundly influenced by an almost insatiable demand for professional men in America. But how real is this demand? The American economy is in an extraordinary situation—all that the population needs to live on, all the roads, food, housing, cars and clothing they need can be provided by the efforts of half the working population. The United States has several millions of unemployed but, as tradition demands that men should work if possible, the government has to find work for millions. They already have the nuclear equivalent of several tons of TNT for every man, woman and child on the surface of the Earth and so they have diverted their resources from defence into the attempt to put a man on the Moon, which has become the most highly organised system of outdoor relief ever devised by a civilised society in peacetime. The extraordinary scale and extravagance with which it is being organised provides an irresistible attraction for people to go into America. The purposes for which they are "needed" are almost flippant compared with the desperate human needs of the more primitive parts of the world. Yet scientists and technologists do their best to migrate to America, just as others are attracted to come here either directly or indirectly by our own defence programme. Nearly two-thirds of our scientists are working for defence or for the Atomic Energy Authority. No wonder we need more for industry and teaching.

I believe that, unless something is done to remedy the situation, land in Asia and Africa will remain uncultivated because of America's attempt to put a man on the Moon.

It would be interesting to speculate how far our own situation resembles that in Ancient Rome at the time of the Empire. No one knows how much of the Roman government revenue was spent on the Games; a figure as high as 40 per cent has been quoted, which is little more than America spends on defence and space. Whole areas of the Mediterranean Littoral were denuded of men and wild animals so that they could be tortured to death for the pleasure of the Romans, and the most extraordinary complex civil engineering projects were undertaken in order to make these festivities possible. The Colosseum has survived but we forget the complexity of the works necessary to build a special lake in which a sea battle could be staged, a lake whose waters ran red with blood before the day was out. One must try to see these things in proper perspective; the Romans may have killed more people in the arena in a month than are killed on the roads of America in a year, although cars injure more people than the gladiators did. The Games squandered the wealth of the Empire, distorted the economy of the whole civilised world and denuded the provinces of their ablest citizens and all their resources.

It seems impossible now to discover if enthusiasm for the Games was stimulated by the Roman government, how much of the pressure to develop them came from the contractors who provided the facilities for the gladiators, or how much of it was due to public demand. Many emperors disliked the Games and did their best to stop them and save money. St Augustine's young friend was dragged unwillingly to the games, he closed his eyes tightly until the cry of the mob at the sight of blood opened them and turned him into a life-long addict. Soon afterwards a besieging army attacking a great city found the walls deserted; the invaders entered the fortress unnoticed as the mob howled in the arena.

In answer, then, to the question I posed earlier, about the responsibilities of the migrant scientist to scholarship and to his neighbour, I would say this. National boundaries are artificial and scholarship scorns them. Technologists and scientists must go where they can do worthwhile work. But in deciding what is worth while, they should be conscious of the human needs and values they have come to understand in their own community. They should remember the debt they owe to the society which nurtured them and provided them with their knowledge. And, above all, they must learn to distinguish between bread and circuses. .

American Newsletter

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from Howard Simons

Secret mapping by satellite

WASHINGTON

SOMETIME IN JANUARY—the Defense Department likes to keep these things secret—a bigger Air Force satellite carried a smaller Army mapping satellite aloft and put it into a 600-mile orbit above the earth. Presumably the big still-secret Air Force satellite went its merry way. The only thing that is certain is that the small Army satellite, a 40-pound rectangular spacecraft measuring 9 by 11 by 14 in, is travelling about Earth roughly every 100 minutes and is "working exceptionally well". The mapping satellite is dubbed SECOR (Sequential Collation of Range). Its primary purpose is to test an improved interferometer. According to a Pentagon description of the SECOR satellite system it works this way:

> "Each ground station (four or more, all in the United States, are being used in conjunction with the tests) simultaneously determines its distance from the satellite by first transmitting a frequency-modulated, continuous-wave signal which is received and rebroadcast by the satellite's transponder. During transmission, each ground station measures and records the distance between the station and the transponder. To permit compensation for errors introduced by ionospheric refraction of the SECOR signals, the transponder replies on two different frequencies."

The Pentagon also said that upon successful completion of the current tests, SECOR ground stations will be established abroad by Army Map Service personnel to give military geodesists "more accurate data for use by military map makers".

Not everyone is happy with this prospect, let alone the idea that the military has elected to orbit its own mapping satellite. A few years ago a geodetic satellite programme called ANNA (Army, Navy, NASA and Air Force) was to have been a secret affair. But criticism from White House officials, scientists and the press resulted in the secrecy label being peeled off and ANNA was made available to the world scientific community. As an aftermath of the ANNA controversy, Defense and NASA executed an agreement which gave NASA overall project management for ANNA and follow-on programmes.

On 31 October, 1962, ANNA 1B, carrying an interferometer, a flashing beacon and a Doppler shift transponder, was sent into orbit. Since that time an intergovernmental planning group has met to frame future mapping satellite activities. Defense officials insist that the Army SECOR is a part of the follow-on ANNA programme and the improved interferometer will eventually be flown in another ANNA. Moreover, they say, the SECOR launch had NASA's blessing—a subject which some other officials debate privately.

In spite of these assurances, the suspicion remains that the military is engaging in a secret mapping satellite effort of its own. And, though the letter of the Defense-NASA agreement on mapping satellites is being satisfied, the spirit of the agreement seems to be wanting. The Pentagon's official notice that the satellite is in orbit—issued at least a month after SECOR was sent aloft—failed to note, for example, that the scientific information from SECOR will be made available to the world scientific community. Rather, this commitment, which was at the heart of an earlier ANNA controversy, was given by a high Defense official to a newspaper.

*

THE SELECT COMMITTEE on Government Research of the House of Representatives, called the Elliott Committee after its Congressman-chairman, has promulgated its first progress report on the character and aims of American science. The report is based largely upon the Committee's assessment of what it heard from 75 witnesses from government and private scientific establishments. As might be expected, the report raises more questions that it answers and clearly the Committee's real work still lies ahead. To this end, the Committee has authorised its staff to begin work on ten separate studies "designed to divide the complex subject into meaningful and manageable parts". The areas for further inquiry, each of which will constitute a separate report, range from fiscal and contractual policies and procedures to student assistance in higher education.

Some idea of what is already bothering Committee members, and what hopefully, the studies will illuminate, can be gleaned from the assignments to the staff study groups. Thus, for example, one study will seek to measure and assess the impact of Government-sponsored research and development upon various segments of the nation's economy. The reason: growing concern that "a more than generous share of the infinitely larger funds spent for applied research and development is also concentrated in a handful of States". And a group created to study national goals and policies has been enjoined to identify the existence or lack "of explicit departmental, agency, and national research and development missions, policies, and goals" as well as to identify priorities or the techniques for doing so.

The Select Committee was given a year from its creation in October 1963 to complete its studies. It now appears from the Committee's shopping list that, like so much scientific research, the examination of scientific research will take far more time than the researchers had estimated.

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ATOMIC ENERGY COMMISSION scientists have exploded the notion that they have the wherewithal today to excavate a sea level trans-isthmus canal with nuclear explosives. On the contrary, in spite of considerable progress in recent months toward the development of "clean" and cheap devices the AEC is till at least seven years away from a canal-digging capability. What is more, the seven-year estimate is an optimum which precludes budgetary and test ban treaty limitations, both of which now plague the AEC Plowshare programme.

This was the gist of the AEC's testimony to the Joint Congressional Committee on Atomic Energy and it served to dash the hopes of the unknowing who had embraced the idea of digging a canal with nuclear explosives as an antidote to the Panama situation. It further served to deflate State Department "balloons" that the AEC was working harder than ever on the idea.

The facts seem to be that the AEC is being hindered in its effort to push the development of peaceful atomic explosives by a lack of sufficient funds and by the treaty. In the first instance, the Administration, for economy reasons, slashed the AEC's Plowshare request for fiscal 1964 from $21.5 million to $11 million. Moreover, until an interagency committee decides exactly what can and can't be tested under the terms of the treaty, the AEC's cratering experiment effort is in abeyance.

Science in British Industry

Quick way of measuring a magnet's strength

A neat solution to a difficult problem of assembly has been devised for the construction of this probe, which can provide the physicist with direct means for measuring magnetic field strengths from 100 to 20 000 gauss. The probe uses the Hall effect to provide a reading on a micro-volt meter that is proportional to the field strength.

When a current is passed through a material at right-angles to the direction of the magnetic field, which also cuts through the material, a small voltage develops across it, mutually at right-angles to both current and field. This "Hall voltage" is proportional to the field strength. It is much greater for semiconductors than for conducting materials, and in this case a crystal of a semiconducting compound, indium antimonide, 6 mm by 6 mm by 0.25 mm thick, provides the operative portion of the probe.

The difficulty lies in attaching the voltage and current leads exactly midway along each side of the square crystal, since very small inaccuracies can give rise to a substantial error voltage. The answer arrived at by the firm of Scientifica, Acton, London, w3, which is developing the probe as a kit, is to attach the leads not to the sides but to the corners of an accurately-shaped, square crystal. In this way the leads are "self-aligning" and much more easily soldered, and give the maximum voltage for a crystal of given area and thickness; a greater output can be obtained by thinning the crystal still further.

Keeping the fuel fluid despite the cold

AMONG the many troubles which resulted from exceptionally cold weather a year ago, one, on which the Institute of Petroleum has just published a report, was the blocking of diesel-vehicle fuel systems by wax crystals. Substantially the same trouble was also encountered by some householders, whose oil-fired central heating systems went out on exceptionally cold nights because fuel oil did not flow to the burners from outdoor storage tanks.

Although conditions in Britain during the 1962-63 winter were exceptionally severe, the Institute of Petroleum's committee (which included representatives of fuel suppliers, engine and vehicle builders, and the Motor Industry Research Association) recommends that fuel suppliers and vehicle builders should both take steps to reduce the risk of similar troubles recurring.

Hydrocarbon liquid fuels used in diesel engines do not have a simple freezing point, but thicken gradually as the temperature reduction causes wax "crystals" to form in the liquid. The Class A fuel specification of the British Standards Institution does not at present define the low-temperature fluidity required of a fuel, although a change is being considered. The two accepted criteria in this respect are known as the "cloud point" and the "pour point". At a cloud point temperature (often around -8°C) visible crystals form in diesel fuel; although the fuel will still flow through pipes and can be pumped, the small wax crystals can accumulate on a fine filter and cause a blockage of the fuel system. At a lower pour-point temperature (typically around -15°C) wax crystals have spread through the fuel to such an extent that it can no longer behave as a liquid.

Over the temperature range of about 7 C, between the cloud point and the pour point of diesel fuel, vehicle design factors can determine whether or not it is possible to start the engine and run it at its normal power output. The detailed recommendations of the Institute of Petroleum are, in essence, to get fuel as directly as possible from its storage tank to a point at which it can be warmed by engine heat, and not to use any suction filter finer than a 40-mesh strainer in the unheated part of the fuel system. Unless a radiator blind is fitted and used correctly, little heat is dissipated from a diesel engine's cooling system for some time after a start from cold. Thus a filter located just behind the cooling fan on the front of an engine may become blocked with fine wax crystals almost as easily as one remote from the engine.

Chemical additives exist to lower the pour point of fuel oil, but their effectiveness varies greatly with the nature of the base fuel to which they are added. As an emergency treatment, kerosene added to diesel fuel oil increases the solubility of the wax compounds, 15-20 per cent of kerosene making engine operation possible at temperatures some 3° C lower, and a doubled "dose" roughly doubling this gain.

In brief . . .

A CONVERTIBLE SEAT whereby the accommodation of an airliner can be switched quickly from first to tourist class and back has been invented by BEA's chief project and development engineer, Mr R. C. Morgan, and will be introduced in the Corporation's Trident aircraft. It will then be possible to change the capacity of the cabin from 80 seats (16 first, 64 tourist) to 88 seats in a matter of minutes.

* * *

EXPERIMENTAL explosive forming equipment capable of fashioning metal parts up to 4 ft in diameter has recently been completed at the Production Engineering Research Association, Melton Mowbray, at a cost of £1000. A press to fashion components as large as this could cost £30 000. It is built around a reinforced water tank, 6 ft deep and 6 ft in diameter, sunk into the ground and seated on 12 in. of concrete; a curtain of air bubbles protects the tank from shock waves.

Keeping London dry by telemetry

LARGE AREAS of south-west London were once marsh, and sewage and storm water have to be pumped away from this low-lying land, so new pumping stations are still being brought into use. The old stations used pumps driven by oil or gas engines because electrical supplies were thought not to be reliable enough, but this situation is changing. In fact, innovation is extending to the introduction of telemetry and automatic control.

The latest and biggest automatically controlled station, at Heathwall (*Control*, Vol. 8, No. 68, p. 91), has ten pumps; three of them lift "comminuted" sewage 19 feet from the new Heathwall sewer for transmission to the Crossness sewage works. Six of the pumps handle flood water, and are brought into action automatically when signalled from electrodes in the storm-water suction culverts. The tenth pump disposes of the residue in the culverts when the storm-water pumps are not working.

Water level is measured by diaphragm devices in the comminutor approach channel on the suction side of the sewage pumps, and in the storm-water suction culverts. The measurement is locally indicated and recorded, and so is the direction of change. A rising or falling signal is sent to a control centre. The state of the pumps, electricity supplies, comminutors and screens is monitored and also signalled to the control centre.

All these signals are combined by sequential relays and passed to telephone wires in time-division-multiplexed form. The duty order of the available pumps is digitally displayed at the centre, and if the automatic starting circuits are not correct then the operator is warned. At present, the information transmitted to the control centre is recorded there by the operator, but once the next two telemetry links have been installed an automatic data-logger is to take that job over, too.

How long can grain be stored?

BARLEY, wheat, oats and other grain that is to be converted into malt and used for brewing is usually dried with hot air immediately it is harvested and then stored in large bins until required. Although the grain can be cooled by aeration, it may take some time for the bulk to cool, and it is found in practice that storage temperatures are often higher than 30°C; also, each grain holds a certain amount of moisture within it. The adverse effect that these conditions have on the "germinative energy" of the grain — the energy that enables it to sprout (malt) and to produce enzymes which are used for brewing — can be quite marked. Although it is known that, under good conditions, barley can be stored for as long as 29 years without it deteriorating—without reduction of viability, that is—it was not known until recently how long the grain can safely be kept under the rather severe conditions described. This has now been determined as a result of experiments carried out jointly by Miss D. M. Edwards of Munton and Fison, and H. D. Burges, N. J. Burrell and M. E. Cammell, of the Pest Infestation Laboratory at Slough (*Journal of Science in Food and Agriculture*, Vol. 14, p. 580).

Two separate batches of barley, having moisture contents of 12.8 per cent and 13.3 per cent, respectively, were each thoroughly mixed and divided into 28 portions, giving 56 samples in all. Each portion was placed in a linen bag and the bags sealed in jars, seven to a jar. Two jars, one at each moisture level, were stored at four different, carefully-controlled temperatures—at 17.5°, 32°, 35° and 40°C. The researchers prevented carbon dioxide from accumulating in the jars by placing a small tube of potassium hydroxide solution in each.

At selected intervals, samples consisting of 100 grains were taken from the bags and their moisture content and germinative energy measured, the former by weighing before and after drying for four hours at 113°C, and the latter by keeping the grains on moist filter paper for three days, at a temperature of between 20° and 21°C, and counting the grains that sprouted each day. The results of these carefully controlled tests show that there is a definite relationship between storage temperature and germinative energy; the higher the temperature the sooner is the energy lost. Of course, the grain moisture content has an important effect, too. In practice, this means that grain with a moisture content of less than 14 per cent can be left at 25°C for long periods without fear of it deteriorating; at 30°-35°C, grain with less than 13 per cent of moisture cannot be safely left for longer than eight weeks; and at temperatures above 35°C the maximum safe period is likely to be no more than 3 weeks even with the same limitation on moisture content.

An important practical point, too, is that these safe storage times apply only to grain that is not heating up in storage due to the attack of moulds and granivorous insects; when these are present the situation is likely to be much worse. Just how much worse is the subject of experiments now under way at the Pest Infestation Laboratory.

The National Heating Awards 1964 is open to heating engineers, architects and architectural students, electrical, gas and other fuel engineers, management, engineering, design, development and other persons employed by fuel undertakings, appliance manufacturers and distributors, under the age of forty. Entrants must prepare an essay, not exceeding four thousand words—with drawings as required—about the theme "Domestic Heating of the Future—A Projection Towards A.D.2000". Sponsored by The Valor Company Ltd.

Closing Date October 1, 1964. Entry Forms and full details from **Norman J. Hart, National Heating Awards, 166 Shaftesbury Avenue, London W.C.2.**

NATIONAL HEATING AWARDS 1964

FIRST AWARD 500 GNS

SECOND AWARD 250 GNS

THIRD AWARD 100 GNS

AND FIVE AWARDS OF 50 GNS EACH

ASSESSORS **The Lord Bossom of Maidstone,** F.R.I.B.A., LL.D. **Lewis Cohen,** Managing Director, The Alliance Building Society. **Professor Robert Gardner-Medwin,** F.R.I.B.A., F.R.I.A.S., M.T.P.I. Roscoe Professor of Architecture, Liverpool University. **J. Richard Harrison,** A.C.G.I., B.Sc. (Eng.), D.I.C., M.I.C.E., A.M.I.E.E., M.I.H.V.E., F.N.Z.I.E., M.Con.E., President, The Institution of Heating and Ventilating Engineers. **Dr. David R. Scott,** M.Sc., F.Inst.P., M.Inst.R., A.M.I.Min.E., A.M.I.H.V.E., A.M.E.M.E., Head of College, National College for Heating, Ventilating, Refrigeration and Fan Engineering. **Michael J. Montague,** Managing Director, The Valor Company Limited.

Science in Overseas Industry

UNITED STATES "Rubbing" metal away

AN ELECTROCHEMICAL technique for dynamically balancing a rotating assembly such as a shaft or armature, or for removing burrs or unwanted metal, has been developed by a New York firm, Selectrons Limited.

The technique is based on a method of electroplating, developed some ten years ago, in which the electrolyte is retained in an absorbent pad which is rubbed or stroked over the surface to be plated. The crux of this process is an electrolyte, based on organo-metallic compounds dissolved in an organic solvent, which decomposes entirely into metal, water vapour and carbon dioxide so that no inorganic compounds accumulate in the pad to reduce the electrochemical efficiency as plating proceeds.

The metal-removing technique is a reversal of the plating process, in which the workpiece is made anodic and the electrolyte, retained in a cotton pad surrounding the hand-held graphite cathode (see photograph) is used to dissolve metal by electrochemical attack. Very close control can be exercised over the rate at which metal is removed, through the amperage and the choice of electrolyte, and the surface can be pared down in increments only 10 millionths of an inch thick. Specific electrolytes have been developed for nickel, chromium, iron, cobalt, zinc and copper.

Excess metal and burrs can be "rubbed away" by this electrolytic technique.

Boiling potassium to transfer heat in space?

ANY POWER PLANT designed for use aboard a space vehicle must satisfy two requirements—low weight and high reliability. Regarding the first, an important contribution to the total weight of a system having a source of heat and a turbogenerator is the radiator needed to dissipate waste heat. Its weight depends on the working fluid chosen. A survey carried out back in 1958 showed that, in this respect, the vapours of sodium, potassium, lithium, rubidium and caesium metals were similar, and greatly superior to steam, air, hydrogen or helium. For the first group a radiator might weigh about 4 lb for each kilowatt of electricity; for the second, the figure would be ten times as high.

In choosing between the five metals, the density of the vapour as it leaves the turbine on its way to the radiator is of interest, as low densities lead to large, heavy turbines and ducts. On this ground, sodium and lithium can be eliminated, according to A. P. Fraas of the Oak Ridge National Laboratory, Tennessee (*Nucleonics*, Vol. 22, No. 1) and rubidium and caesium can at the moment be discounted in view of their cost and the difficulty of obtaining them in a pure enough state. So Oak Ridge nuclear engineers, wishing to develop a nuclear-powered system with an output of 100-300 kilowatts, chose boiling potassium as the somewhat unconventional working fluid.

The requirement that the system should be capable of operating for something like 10 000 hours without attention—a demand seldom made on ordinary plant—led to the same choice. High reliability is most likely to be achieved if the system is kept as simple as possible. The two-cycle system, in which there is one fluid to take heat from the reactor and another to drive the turbines, with an intermediate heat exchanger, is inherently less reliable than one in which a single fluid performs both functions, and also serves to lubricate the turbine and generator bearings; this is possible with boiling metals. Mercury, however, has received far greater attention in the past than the metals of the potassium group.

Given the choice between the two, potassium was selected, on the grounds of having better "wetting" characteristics when in contact with chromium-nickel stainless steel, offering better heat-transfer, and of being lighter. The weight of radiator needed per kilowatt, too, would have been greater using mercury.

The whole system, based on a reactor temperature in the region of 950°C, should weigh about 30 pounds per kilowatt.

GERMANY

American horsepowers for European cars

THE "HORSEPOWER RACE" between rival American car manufacturers, which seemed to have ended, now looks like being restarted by the European subsidiaries of American corporations. In Britain, one American-owned car factory has been advertising "Get the power to lead" and the other followed with advertisements inviting motorists to "Learn what it means to have 113 brake horse power right where you need it". Now Opel, the German subsidiary of General Motors, has introduced a new range of six-cylinder cars in which a V-8 engine developing 190 brake horse power is an option, claiming that this engine gives their five-seat saloon a top speed of 124 m.p.h.

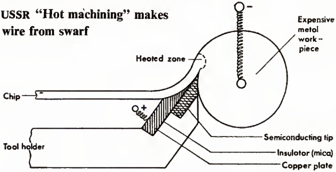
Americans in Germany will recognise the new Opel engine as a Chevrolet design, its importation being no surprise since General Motors have for some time past been supplying automatic gearboxes for their British, German and Australian cars (Vauxhalls, Opels and Holdens) from the United States. With a 98.4 mm bore and a 76.2 mm stroke, this 4638 cc engine uses a 9.25:1 compression ratio, whereas the smaller-bore Opel six-cylinder engine has a ratio of only 8.2:1; in the usual American manner, this high compression ratio is used mainly in the quest of acceptable thermal efficiency in a large engine running throttled, and at maximum throttle opening (rarely needed for many seconds at a time), power and thermal efficiency are sacrificed by over-rich carburettor settings and over-retarded ignition timing which permit knock-free operation on 90-octane petrol.

As much as 78 per cent larger in displacement than the "six" which it can replace, and catalogued as giving 90 per cent more power at the same peak speed of 4600 revolutions a minute, the V-8 engine is kept light by its compactness and by the American talent for making exceptionally thin-walled iron castings. Its installation, and accompanying extras such as power-operated windows and hydraulic power-assisted steering, adds only 10 per cent to the weight of the car.

In contrast to this big step-up in the

performance of a roomy German saloon, the British six-cylinder Austin Healey sports car, which, it had been rumoured, might also be acquiring a larger engine, has instead been given larger carburettors and a high-left camshaft, which produce 10 per cent more power without change in its 2912 cc engine size. With a claimed top speed of 130 m.p.h., this two-seater retains a 5 per cent advantage over the German saloon.

USSR "Hot machining" makes wire from swarf



AN UNUSUAL *way of avoiding waste when rough-machining expensive metals has been put forward recently by a Soviet engineer, L. Yutkin. The workpiece is first heated by passing an electric current through it as it is being machined so as to produce a continuous chip in a "quasi-plastic" state (see sketch); this chip is then drawn or rolled into wire. An r.f. induction coil can be placed around the chip to heat it further, just before it enters the drawing or rolling mill, if this should prove necessary. Yutkin's idea (described in Izobretatel i ratsionalizator, No. 11, 1963, p. 22) is that current should be supplied through a copper plate attached to the cutting tool rather than through the tool itself. The tip of the tool, made from, say, semiconducting carbides, should be insulated from the copper by a layer of mica.*

In brief . . .

A LASER mounted like a gun forms the basis of a radar system developed at the Stanford Research Institute, Menlo Park, California, for the study of atmospheric formations. Reflections have been obtained from heights up to 30 miles; in addition to the measurement of cloud heights, speeds and possibly compositions, the device may be able to predict "clear air turbulence"—a serious hazard to high-altitude aircraft.

* * *

A SMALL pneumatic harvester, originally designed in Australia for collecting the grain from small experimental plots of wheat at research stations in Victoria, is proving popular in other countries, particularly in Africa and Asia. The machine, which is self-propelled and easy to manoeuvre in confined areas—it is little bigger than a wheelbarrow—strips the grain from standing crops. It can deal with 2.5 acres a day, taking in the ears in 2-feet widths. Recently, Australia presented one of the machines as a Colombo Plan gift to Burma for harvesting rice. Other machines have gone to Kenya, Portugal, Fiji, China and the United States (*Australian Agricultural Newsletter*, Vol. 4, No. 12).

A NEWLY LAUNCHED, 4800-ton oceanographic research ship, the CSS *Hudson*, will embark on its first major task, a three-month study of the Hudson Bay, in July. Dr Bosco Loncarevic, of the Bedford Institute of Oceanography, is to supervise this project, which will include a seismic study aimed at finding out whether the Bay is, as has been suggested, centred on a two-mile-deep sedimentary basin; also continuous gravimetric, magnetic and topographic observations, and photography and sampling of the sea bed.

* * *

A "CONTAINER VESSEL", designed to carry a number of small loaded barges, developed by the Mitsui Shipbuilding and Engineering Company, is undergoing sea trials in Japan. Known as a "pallettex ship", the craft consists of a mother ship having small, laden barges stowed within it, one on top of another. At the destination, the mother ship submerges, setting the barges afloat. The system is expected to simplify the loading and unloading of cargo, while eliminating the disadvantage of the barge line system—the linking of barges end to end for towing by a ship—of its being vulnerable to stormy seas.

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Government in 1984

Unconditional surrender to facts?

by Professor Asa Briggs

Dean of Social Studies, University of Sussex

THERE are several common 20th-century trends in the government of most countries. Outstanding among them are an increase in governmental functions and in the number of people administering them, a collective pre-occupation with economics and social purpose, and a popular personalisation of politics made the more effective by modern mass media of communication.

There is no reason to believe that any of these trends will be reversed between now and 1984. Each trend, however, will reflect new tendencies. Governmental functions are likely to depend more and more on long-term assessments of the future, and the people administering them will require more of a logistic and less of a bureaucratic training and outlook. There are likely also, in relation to this first trend, to be checks and swings, with new checks being devised both in non-communist and communist countries, and with swings of opinion and control, the swings never restoring an old situation exactly as it was.

The second trend will involve governmental concern with the public implications of social and economic issues which are at present only dimly formulated, among them automation in highly developed economies and, in undeveloped or developing countries, action to develop the real constituents of economic enterprise. Disillusion with the rhetoric of economic growth is as likely to disturb new countries in the 1980s as the impact of political men on customary social structures has done in the recent past. The reaction of government to disenchantment may be politically repressive or socially adventurous: in either case it will probably emphasise even more than today the need for strong leadership. We shall not exorcise the charismatic element from government.

In 1984, the third of the twentieth-centry trends, that towards political personalisation, may conceal from the public even more than it does today the realities of politics and administration. New countries lean heavily on myths of individuals. Old countries in their international contacts make more and more of them. Detailed background work on long-term plans, including intelligence and research, will place great power in the hands of people relatively unknown to the public, but at the same time it will make the techniques and arts of presentation more, not less important. Yet educational changes will increase—in all countries—the number of critical observers of the process: the main resistance to the misuse of governmental power will lie here rather than in intermediate institutions created in the past. It will not always be an adequate check—further institutional checks will have been sought and in some cases found—but government will always have to take account of it.

Yet, in 1964, behind the common trends in government there are immense divergences between the different governments, and we lack adequate typologies to sort them out. For this reason, even if the biggest issue in international politics is left on one side, our ability to avoid nuclear war, all forecasts of what will happen within domestic government or between governments are extremely hazardous. Indeed, there is likely at the same time to be both more conflict and more cooperation. The very units of government themselves are likely to be different in 1984. In Africa and Asia inherited sovereignties and frontiers are likely to be disputed through sequences of "crises", although there are powerful nationalist tendencies to confirm flamboyantly what on social and economic grounds seems to have little *raison d'être*. By 1984 it should be clear, after protracted uncertainty, whether or not 21st-century Africa will follow the pattern of 19th-century Latin America.

In Europe—and across the Atlantic—a considerable amount of government, particularly in economic matters, constituting a far greater segment of government than now, is likely to be shared between countries. Through the politics of science, of food and of disarmament this sharing may cut across power divisions. Yet many of the forces making for increased sharing of government are likely to be removed from public scrutiny, perhaps even more if there were a long period of co-existence. For most countries, the margin of choice in politics is likely to be still further narrowed, less for reasons of ideology than through "unconditional surrender to facts". At critical points in the process of narrowing, however, there may well be what, at least superficially, will seem to be dramatic moments of decision.

The biggest divergence in government now is between "old" countries faced with the formidable task of adapting or radically overhauling inherited institutions and procedures and "new" countries creating political complexes, including political parties and civil services, for the first time. In both cases there is strain, caused in the one case by too many overheads, in the other case by too little capital. On each side, also, considerable imaginative sympathy—even more than detailed factual knowledge—is necessary to bridge gulfs. The gulfs may have widened and deepened by 1984.

As far as the "old" countries are concerned, the shape of government in 1984 will depend in the first instance on

EIGHTH WEEK OF 1984 SERIES

In this series the contributors have been asked to forecast conditions in 1984 on the basis of known possibilities and trends. It is recognised that a certain amount of guesswork is unavoidable and that unforeseeable discoveries and inventions could, in some cases, radically alter the picture.

Next Week: "Telecommunications in 1984"

the will to make sweeping changes in the 1960s and on the extent and character of the social as well as the political overhaul. In the second instance it will depend on more long-term changes in social structure and economic achievement. In Britain, for example, government will probably be increasingly professionalised, although each particular government may rely more on sympathetic expert assistance from outside than has been common in the past. Mobility in and out of administration will probably have extended from economists to other social scientists and probably to people in labour and business. Central government will be better informed in respect to both the quantity and quality of information, more active in seeking to encourage enterprise and control social change, more concerned with the long-term effects of its policies. Treasury control will have given way to production planning, but the psychology of industrial relations will still preoccupy the planners.

Parliament, either by decisive action or relentless cumulative pressure, will probably have reformed many of its procedures, and a more intelligent use will be made of parliamentary committees in matters both of economics and international politics. There will still be "dignified" parts of the constitution, increasingly divorced, perhaps, from their public-service origins. The old ideal of public service will have been battered, and there will be a search for substitutes. The role of political parties will have been modified considerably within a framework of long-term planning, but their rhetoric may not have substantially changed. Their behaviour will be more carefully scrutinised by those "critical observers" whose numbers will increase, but this scrutiny may in itself lead to greater demands for increased political participation. There will be no substitute in the British type of political system for free elections, although the psychology of elections is likely to create as much interest in the future as psephological statistics do today.

The "new" countries are likely to diverge more from each other in 1984 than they do today, with the future of many of them depending on their willingness to accept ideas and policies which at the moment command only very limited assent. In some of them, at least, what at present seems to be an "interim" pattern of government will have come to an end and, within a new economic and social framework, some of the same problems will be posed which have been posed in other parts of the world in the past. There will probably be more talk, indeed, of old problems than of new countries, with food, population, unemployment, technology, economic enterprise, and political rights, central issues of policy.

Such general forecasts pre-suppose avoidance of general nuclear conflict or of international economic cataclysm. They are by no means incompatible, however, with continuing outbreaks of violence or with a series of economic crises. It is difficult to go further than this because government for the most part registers change before it speeds it up or regulates it, and the positive response which is necessary before change can be accelerated is not always forthcoming. People count, both in power and out of it. Out of the experience of change, whether or not it is initiated by government, there will probably emerge new political theories, pushing beyond the frontiers of Marxist and anti-Marxist debate, some of them emerging within Marxism itself. Quite apart from the pressure of economics on government policy or the greater influence of applied psychology, these theories themselves are likely to be in universal circulation by 1984. And it will be difficult, given the communications revolution, for any government to insulate itself from them.

Communications and government

by Dr V. K. Zworykin
RCA Laboratories, Princeton, New Jersey

GOVERNMENT, to be good, must be informed; to be democratic, it must be controlled by an informed citizenry. These conditions can be realised only by an efficient system of two-way communication between the people and their governmental agents.

The problem of presenting the government's message to the people has found an adequate solution. Broadcast radio and television not only enable heads of governments to address themselves to their total constituencies at short notice, but permit minor functionaries as well to acquaint people in limited areas concerning school closings, road alterations, countermeasures for epidemics and other matters of importance for the efficient operation of society.

By comparison, the ways open to the people for making their wishes known to their representatives appear quite inadequate. The one official channel available for this purpose is the vote. The cumbersome business of preparing and printing the ballots, setting up the polling places, and requiring voters to present themselves there at appointed times, limits both the frequency of such expressions of public opinion and the range of issues covered by them. More often than not, the election centres on a personal contest between candidates and the issues responsible for success or failure become the subject of a guessing game for commentators, candidates, and campaign managers. The extensive use of unofficial public opinion polls is a natural consequence. Yet, these too, apart from being subject to sampling errors, are too time-consuming to give the people an effective voice in time of crisis.

This limitation on the democratic process is not at all necessary. As I have had occasion to point out in my Clerk Maxwell Memorial lecture to the British Institution of Radio Engineers (*Journal of the Brit. IRE*, Vol. 19, p. 529), modern technology makes it possible to give the people the ability to communicate their wishes and opinions to the government with a directness and immediacy comparable with that realised at present only in the opposite direction.

To be sure, doubt may be expressed as to the desirability of direct popular control of public policy. The past experience with the direct democracy of ancient Athens and the town meeting may be interpreted either favourably or unfavourably or even regarded as irrelevant, in view of the greater complexity of the questions presented to modern governments for decision. Three comments may here be in order. First, in direct democracy as in our present-day representa-

Government in 1984 *continued*

tive governments, it may be assumed that only broad policy decisions would be made by laymen and that details would be left to the judgment of a hierarchy of technical advisers. Second, being repeatedly called on to participate in public decisions can be expected to stimulate in the citizen an increased sense of responsibility and a desire to inform himself on public questions; thus the practice of direct democracy can help to develop the preconditions for its success. Finally, whatever the manner may be in which the expression of public opinion is translated into the control of public policy—and I cannot pretend to any special knowledge in this field—it would certainly be of value to those who guide the nation to have an accurate index of public attitudes on important issues. For this last reason alone we might expect that, by 1984, governments will have availed themselves of the technical possibility of accurately gauging popular response to current and projected policies.

In the technically advanced countries of today, the desired two-way communication between citizens and government is made possible by the existence of two parallel communication systems with practically complete coverage of the population—the broadcasting system and the telephone system. For example, in the United States, with 82 million telephones serving a population of some 190 million, it would be a relatively simple matter to "assign" every voter to a particular telephone, a limited number of public telephones taking care of non-subscribers.

In the system envisaged, every telephone would be provided with simple auxiliary equipment, which would convert it into a voting station. Registered voters assigned to the station would then be in a position to express their preferences on specific questions submitted over broadcast channels at any pre-assigned voting period in much the same manner as citizens today use voting machines for expressing their opinions in a referendum. The important difference resides in the fact that such a poll could be conducted at any time, upon a few hours notice; that the voting would be carried out predominantly at home, without delay or interference with the normal routine of the voter; and that the returns could be known within an hour after the voting had been completed. For details as to how this might be accomplished the reader is referred to my earlier paper. As indicated there, the obvious requirements that only qualified voters participate in the vote and do so only once can be met without difficulty.

Let us assume that, by the year 1984, a basic reform of this nature in the recording of public opinion has been carried into effect. What would be the consequences? First of all, government leaders would be able to align their policies more closely with the popular will, which would be known rather than a subject for speculation. In this manner they might avoid forced reversals of policy and give government a greater degree of continuity. Even more important, the frequent consultation of the individual voter on specific issues would tend to overcome his feeling of political ineffectiveness and provide him with a recurrent incentive to become better informed on matters of public policy. In this manner we may hope that, in 1984, an appropriate application of modern communication techniques may strengthen the basis of effective democratic government by creating a better informed and more vitally interested citizenry and rendering government more responsive to its will. An effective way would have been found for the citizen to communicate with his government and for the government to become aware of the popular will.

Computer models of the economy

Professor Richard Stone

Faculty of Economics and Politics, University of Cambridge

IN the last generation an important new development in economic analysis has been the construction of computable models of the economic system. There is much talk nowadays about economic models, in spite of which many people may still be wondering what an economic model actually is. It is not a parsimonious blonde or a 50 m.p.g. minicar. Nor is it a piece of mechanical or electrical apparatus. It is a set of algebraic equations intended to reflect the facts of economic life and to show how these facts are related to each other.

A very simple example of an economic model, which is not, however, without some interest, can be set out as follows:

(i) an accounting relationship which says that income (or output) equals expenditure plus saving, or $y=e+s$;

(ii) another accounting relationship which says that saving equals investment, or $s=v$;

(iii) a behavioural relationship which says that the community always saves a fixed proportion of its income, or $s=\pi y$, where π denotes the constant proportion of income saved; and

(iv) a technical relationship which says that income (or output) increases in proportion to investment, or $v=\rho\dot{y}$, where ρ denotes the capital-output ratio, namely the number of £'s worth of capital needed to produce one £'s worth of output and $\dot{y}$ denotes the change of income over a certain period.

An economy governed by these four relationships will grow at a rate of π/ρ, which means that in order to grow faster it must either save a larger proportion of its income, that is increase π, or learn to use less capital per unit of output, that is reduce ρ. For example, if it saves 10 per cent of its income and has a capital-output ratio of 2.5, it will grow at a rate of 4 per cent; if it could either increase its saving to 12.5 per cent or lower its capital-output ratio to 2, it would grow at a rate of 5 per cent. Thus we can see what would have to be done if that economy wanted to change its rate of growth.

The four equations given above constitute a toy model, so to speak. Obviously, if an economic model is to reflect adequately the complexity of the real world, it must be much more complicated. Indeed, some of the models now in existence contain thousands of relationships, each capable of being translated into an arithmetical operation. But when it comes to putting figures in the place of letters, the calculations involved are discouragingly formidable. On the other hand, until the relationships have been checked in the light of figures, nobody can be absolutely certain of their validity. For this reason the production of economic models has until recently remained, with very few exceptions, within the confines of academic research. In the last few years, however, the enormous strides made in the development of computers have revolutionised this activity and opened up the possibility of making quantitative models which will be detailed enough and reliable enough to play an important practical role in government and business planning.

This role will consist not in telling people what they are to do, but in giving them more information on which to base their decisions. After all, an economy is nothing but a system which transforms information into decisions; so a necessary condition for its efficient functioning is that an adequate amount of information be available in the right place at the right time. A market mechanism does not automatically generate this information. Many public and private bodies try to remedy this deficiency by making special surveys, projections, etc. But just because the economy is a system, because, that is, its different parts are interdependent, the task is very difficult for any group or individual working in isolation. A central planning mechanism runs into the opposite problem: it is hopeless to try to concentrate all decisions at a single point, because sufficient information cannot be concentrated there. The result in both cases is that, too often, apparently wise decisions miscarry, well-meaning efforts are frustrated and valuable resources, both material and intellectual, are wasted.

More and more people are recognising these difficulties and looking to economic models as the most promising tool for overcoming them in the future. All over the world, economists, with the help of computers, are working at perfecting such models. I shall give a single example of what this kind of work entails.

In the last four years a group of us at Cambridge has been engaged in building a computable model of the British economy. Progress reports on this work are published in the series *A Programme for Growth* (Chapman and Hall, London). We now have a working prototype which, while still much in need of improvement, shows that the task is a manageable one.

Briefly, our first endeavour has been to build up a picture of the economy in 1970 based on specific assumptions about the standard of living in 1970 and about its rate of growth thereafter. The economic consequences of these assumptions can be set out as a series of balances: (i) the balances of supply and demand for the 31 product-groups distinguished in our model; (ii) the balances of revenues and costs in the corresponding branches of production; (iii) the balance of supply and demand for labour; (iv) the balance of saving and investment; and (v) the balance of Britain's external account.

Some idea of the part played in this exercise by the computer can be gained from the following figures. The whole economy is represented by the entries in a set of 253 balancing accounts. Each account shows the incomings and outgoings of some branch or sector of the economy. The numerical inputs (parameters and conditions) needed for a computer-run number between 5000 and 6000. A run involves about 30 million multiplications: on a desk calculator this is equivalent to 60 man-years of work; on the Atlas computer it takes 22 seconds.

From this experience it seems to me legitimate to suggest that, by 1984, a computable model of the economy, covering all aspects of economic life and perhaps some aspects of social life too, will be an established part of the machinery of economic organisation. This model should not be thought of as a huge single entity but as a multiple one, a system of models, in which the central model will provide no more than an outline of the whole picture and will be connected by data-links to a series of sub-models. Each sub-model will work out the details of some aspect of the whole: some branch of the productive system, say, such as the power industries or the transport network; or a social service, such as education or public health. Each sub-model will rely for its inputs partly on the output of the other models and partly on a running supply of current statistical information; for by then the country's statistical services will be entirely run on computers, and basic sources such as the census of population or the census of production, which now take months and years to compile, will be available on the ticker-tape. Finally, each sub-model will be handled by a group of people with an intimate knowledge of the activity concerned and, apart from the exchange of outputs, will be operated independently of the others; in addition to its other advantages, this arrangement will ensure that the requirements of government and business secrecy are respected.

For any chosen target, the model-system will produce a complete picture of the economy in which every detail will be in harmony with the target, whether this be set in the near or the distant future. If the finished picture, or some part of it, appears on inspection to be unacceptable, the target can be modified and the change fed back into the model-system. A new picture will then emerge, and if this is not acceptable either, the process can be repeated until a possible future that seems satisfactory is mapped out. Thus we may hope to see reconciled the advantages of individual initiative with those of central planning.

One final word. Computers do sums, men take decisions. An ability to do sums is likely to change men's opinions on what actions seem sensible; but the responsibility for these actions rests with men, not with computers.

"Report of the Council for Science Policy, 1983-84"

by Dr Alexander King

Director for Scientific Affairs, Organisation for Economic Co-operation and Development, Paris

LONDON, 1984—The British government's Council for Science Policy devotes much if its Report for 1983-84 to consideration of the place of science in the machinery of government. That has been a recurrent theme amid the continual changes in the organisation of science which have taken place ever since the Council was created (from the old Advisory Council) following publication of the Trend report some twenty years ago. The present report is particularly interesting, however, in that it records the structural adaptation which has followed the somewhat belated entry of Britain into the European Federation.

After various unsuccessful experiments in organisation, the basic concept is again that of a single Ministry of Science under a senior cabinet member. It consists of a secretariat and a colony of some twenty specialist research councils for the natural, technological, social and human sciences. Many of these research councils, particularly where very expensive equipment is necessary, operate their own laboratories, as well as field stations in different parts of the world. Earlier criticism of these institutions have largely been met by their gradual relocation on the campuses of the new universities,

Government in 1984 *continued*

and by financial and pension arrangements which allow easy transfer of staff with universities and industry. The other research councils work mainly in financing research in universities and independent institutes so as to provide solid support for outstanding workers in their particular fields, but always within a reasonable balance of effort. The resources now available for this work and the vigour of the programming methods have done much to remove the threat of creeping mediocrity which seemed to menace so many of our research schools in the decade after university financing fell to a monolithic Ministry of Education.

The whole system functions, of course, under the supervision of the Council for Science Policy itself, which exercises control on behalf of the Minister. It distributes money to the constituent specialist bodies; the overall balance of effort is continuously readjusted in the light of new discoveries of scientific importance in all parts of the world, complementary international efforts and the changing needs of economic, social, defence and foreign policy.

The Council is served by the Central Scientific Secretariat, responsible for providing the background data and studies required for a comprehensive science policy, as well as for maintaining day-to-day liaison with "the Plan", with industry and with the specialist research councils. Amongst work in progress are (1) the provision of detailed statistics of research and development expenditure, (2) advanced studies in technological forecasting, (3) special surveys of selected scientific fields and of the research needs of different sectors of the economy, (4) investigations of the relationship between scientific creativity and different types of research organisation, (5) studies to elucidate more clearly the nature and economic significance of technological innovation and of the sociology of change, (6) forecasts of the impact of certain scientific developments on foreign policy, and (7) the development of electronic models of the economy and of research input-output networks.

The Secretariat consists of some 187 professionals, most of whom are natural and social scientists, economists and operational research workers. It is difficult to see how such a small group can seriously hope to undertake the vast range of investigation and analysis required to maintain a realistic and balanced policy, and it is to be hoped that the Minister will assert his authority to prevent this work being permanently weakened by the dominance of immediate Treasury considerations.

Science and "the Plan".—For many years, applied research and development for particular economic sectors came directly under the Minister for Economic Affairs. This separation of applied from fundamental research proved somewhat sterile, in that it encouraged a tendency for industries to miss significant innovation possibilities arising from research in fields which did not seem immediately relevant. Furthermore, quickening rates of innovation demanded not only applied research but ever-increasing efforts of suitably oriented fundamental investigation. Finally, fundamental knowledge in many fields, starting with space research, radio-astronomy and high-energy physics, has required, for its own expensive instruments of probe, the development of new, special technologies.

In fact, the distinction between fundamental and applied research has evaporated—except in terms of objective. It is five years now since all national scientific effort has been restored to the care of a single Ministry of Science. Articulation with economic and social policy is ensured by the presence in the Secretariat of a number of economists from "the Plan", while there is a group of scientists in the latter organisation responsible for the chapters of the Plan concerning research and education for science and technology.

It is interesting to note that the research chapter of the present plan devotes just under 10 per cent of its resources to fundamental research, probably too low a figure in view of the rising costs of equipment in expensive subjects such as interplanetary radiation, photo-conversion and biophysics.

Science and industry.—This section of the report is mainly concerned with reviewing results of work on the function of research in sustained economic growth. On the institutional side, however, it should be noted that there are now only eleven main research associations in Britain, together with some 13 branches of federal research associations having their headquarters in other European countries.

National, federal and international research.—The work of the Science Policy Council has become immeasurably more complicated by the need to balance national research effort with that supported by funds outside its direct control, coming from federal income tax. There has been much criticism of late as to the extent of federal research outside Britain, yet the report quotes a balance of payments study which indicates that for every Eurodollar contributed by the British taxpayer to the federal budget, $1.43 is spent on federal laboratories within the United Kingdom. The present report gives some details of the programmes of the Federal Radio Astronomy Centre at Jodrell Bank, the new Institute of Biosociological Techniques and also the Station for Applied Photosynthesis in Ruanda which is under British direction.

The trend towards international scientific effort, which began in the 1950s, continues. The promise of scientific discovery, its volume and its cost are all so great, that even the largest countries are unable to undertake through their own resources more than a fraction of the desirable investigations. As a result all nations are forced in the direction of cost-sharing through combined research effort. While Britain's adhesion to the European Federation has greatly added to the strength and potential of her research effort, the Federation is itself too small a unit for effective work in the more expensive fields. The recent establishment of a Western Science Council between the Federation, USA and USSR, while mainly concerned with evolving a single work programme on space, will inevitably become involved in other subjects.

Operational research.—A feature of 1983-84 has been the success of the Operational Research Course for Ministers. The scientific approach to political decision-making has for long been resisted and it is only now that the facilities of the Operational Research Centre of the Ministry of Science have been seriously used. This year's course has been attended by 13 members of the cabinet, many junior Ministers and 50 MPs, including a member of the Shadow Cabinet. The purpose of this training is to familiarise politicians with the use of analysed data on current problems prepared by their operational research teams, and to appreciate quickly the consequences of alternative decisions as worked out by computers.

Final decision rests, as always, on individual experience and judgment, so that the political process is in fact strengthened, rather than diminished as detractors have claimed. Despite the current enthusiasm of Ministers for operational research techniques we may suspect that many years have still to pass before major political decision will give as much weight to an accurate and analysed presentation of real facts, as to subjective judgments, founded all too often on outworn concepts of a former party political nature.

THIS MAN

is two people

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Studying the composition of human breath

Using modern methods of identifying trace components, analysis of breath provides a new view of bodily chemistry in health and disease. The proportions of organic vapours change during the day, and the presence of methanol in the breath suggests it is an unsuspected by-product of metabolism

by Professor Stuart Eriksen

School of Pharmacy, University of Wisconsin

THE air expelled from our lungs every couple of seconds is essentially a fluid in equilibrium with the tissues, just as are the blood, tears, urine and bile and the other fluids more commonly associated with studies of the chemicals present in the body. Breath is a special case because, although the lungs are not specifically organs for excreting organic compounds, small amounts of all the volatile materials present in the blood escape by this route, as the air is essentially in equilibrium with the blood across the membranes of the alveoli (the lung's air sacs). Breath therefore gives indications of blood composition and therefore, indirectly, of chemical processes in the rest of the body as well.

From the experimenter's point of view, breath has one great advantage over all the other body fluids available for study—its removal from the body is normal and continuous. Its prime disadvantage is the extreme dilution of the organic materials present, but modern methods of gas chromatography, for separating and identifying very small amounts of organic compounds, have transformed the experimental situation.

The use of the breath as a tool to study body mechanisms has seen most use in two fields: that of law enforcement, where police officers are bent on finding a foolproof method for determining intoxication (see "The breath of a drunken driver", by Dr Peter Stubbs, Vol. 21, p. 75) and that of biochemistry, where the scientist aims at determining the ultimate pathways for the degradation of complex organic molecules by the body's enzymes.

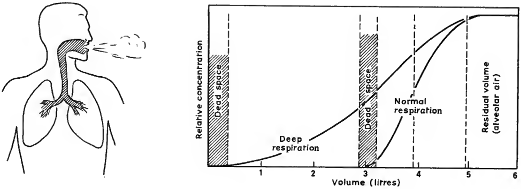
The former use is of course concerned with only one compound, ethanol (ethyl alcohol) whose high vapour pressure and rapid absorption through the gastro-intestinal wall make its concentration in the expired air sufficiently high to be determinable by conventional chemical methods if the suspect has been drinking. When he blows through a tube loosely packed with a chemically treated solid (for instance, acid-chromate solution on silica gel), the reaction of the ethyl alcohol in the breath with the chemical produces a colour change.

Until recently, biochemical studies using breath have usually involved placing a radioactive carbon atom at a known site in a molecule, administering it, and then monitoring the radioactivity of the expired carbon dioxide. In this way, the rates of metabolism of the particular site in the "labelled" molecule can be determined quite effectively. However, the fact that the breath is essentially in equilibrium with the other fluids and gas spaces in the body has not been used to its fullest potential, and suggests that it could be of more general use.

Principles and methods.—Let us consider the implications of such an equilibrium. When we say that the air is in equilibrium with the blood, we mean that the concentrations of materials shared by the two media are what they would be if there were unlimited time for exchanges to take place. At low concentrations, the concentrations of a given substance (say, ethanol) in the air and the blood will be in an almost fixed ratio: doubling the concentration of ethanol in the blood doubles the concentration in the breath. In practice, as we shall see, only a small part of the air in the lungs is in equilibrium with the blood, so we have to make allowances for that. Even so, experiments have shown that this "distribution law" is substantially true for most substances at the low concentrations present in the body fluids, provided that the substance does not change its chemical form when it passes from one medium to the other, in which case we have to be careful about what we should consider. This law and refinements of it also control exchanges of materials at a vast number of boundaries within the body; in particular, the blood passes through all the organs, gaining and losing substances as it goes and eventually sharing what it has left with the air in the lungs.

The breath composition is therefore capable of indicating body compositions in all tissues, provided the distribution constants are known, enough time is allowed to elapse to ensure equilibrium, and the correct molecular form is being measured. For most purposes, however, it is not necessary that the absolute compositions be known, only their relative values and the way these may change. These data can be obtained directly from the breath composition measurements.

Accordingly, we have sought for some time to investigate the composition of breath in a variety of situations. Its composition in health should reflect the relative amounts of all volatile constituents in the blood, both the intermediates and the products of metabolism. Its composition in sickness has rather obvious implications for both diagnosis and treatment. Under various drug dosages, its composition will reflect the amount of any relatively vola-



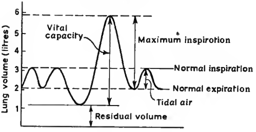


FIGURE 1. (*a*) (*Above*) *The difference in the expired amounts of a volatile substance in the alveolar space (air sacs of the lungs) as a function of the volume expired can be quite marked as shown. The "dead-space" air (cross hatched) contains nearly nothing while the residual air being nearly pure alveolar air has the maximum. Normal respiration includes only a small portion of the amount present in the alveolar space.* (b) (*Right*) *The volume of inspired and expired air can be changed considerably by effort. The "vital-capacity" air can be assumed to contain amounts of volatile material in direct proportion to their amounts in alveolar air.*

tile forms of the drug present in the blood, as well as their effect in altering the pattern of volatile products associated with normal metabolic functions. In order adequately to interpret the latter data we need a complete understanding of the "normal" breath picture and that is what I shall now discuss.

Human breath has been used throughout our preliminary studies, first because it is human information we desire, and secondly because the human animal is in many respects the ideal experimental beast; he keeps himself reasonably clean, well fed and healthy, brings himself up to the measuring device to deliver a sample, and commiserates with the experimenter if the studies are going badly. Few other experimental animals are so cooperative.

Several problems had to be overcome, Only the layer of air immediately adjacent to the lung alveolar membrane can truly be said even to approach equilibrium with the blood, and the efficiency of mixing of the outgoing and incoming air with this layer is not high, nor is its mechanism well understood. This mixing problem produces a situation where the concentration of any one component varies considerably during one exhalation. The initial "dead space" (Figure 1*a*) that air which is inspired last and never reaches the active portion of the lung, staying in the mouth, throat, windpipe, and bronchi, is essentially no different from room air. The alveolar air on the other hand, which is actually in contact with the blood-lung membrane, contains the highest concentrations of volatile constituents and these should normally be essentially equilibrium concentrations.

Normal "tidal air", amounting to only about a seventh of the total lung volume, contains a mixture of "dead-space" air and some portion of the lung volume partially mixed with the air of the alveolar space. Its composition then can vary significantly depending upon the degree of overall mixing, as shown in Figure 1*a*. For studies of equilibrium air compositions, the air must either be pure alveolar, or air obtained from some particular type of exhalation in which the concentrations of volatile substances are in direct and constant proportion to those in the alveolar layer. While the former presents some practical difficulties, it was found that vital capacity air, the air expired between the point of maximum inspiration and maximum expiration (see Figure 1b), can be assumed to contain amounts of volatile materials in direct proportion to their

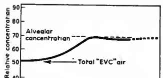


FIGURE 2. *By holding a maximum breath for ten seconds, rejecting some fraction of the total and collecting and analysing the remainder of the expirable breath—called the "equilibrated vital capacity" (EVC) air—the relative distribution of a volatile material in the lung spaces can be determined. The data shown are for paraldehyde. The flatness of the line obtained after 50-70 per cent of the air has been rejected suggests strongly that the remainder of the air is essentially alveolar in concentration. Collecting and analysing the "EVC" should yield a concentration of about 77 per cent of the true alveolar value for the above individual.*

Studying the composition of human breath *continued*

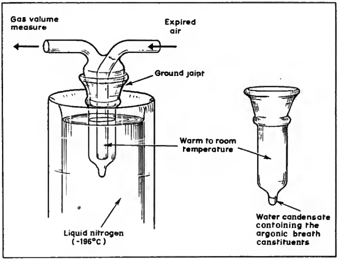


FIGURE 3. *All-glass low temperature condensation apparatus for collecting breath constituents.*

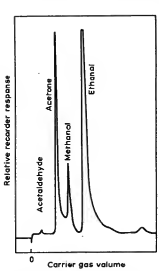


FIGURE 4. *A tracing of a portion of a gas chromatogram showing the three main components of breath, and the position where acetaldehyde would appear if present.*

amounts in alveolar air. The theoretical justification and the relative efficiency of the collection of such air is shown in an experiment conducted by rejecting certain initial portions of the vital-capacity air while collecting and analysing the rest (Figure 2). The degree of equilibration and the fraction of the alveolar concentration represented by the full vital capacity can be estimated from such data and can be reproduced for any one subject if the collection rate and method are carefully controlled.

Although the concentrations of substances in the normal expired breath are not at all the true equilibrium values but something considerably lower, some methods give as much as 60-70 per cent of the equilibrium value.

The low concentrations occurring in expired air present another problem concerning its collection. The minor and perhaps the more interesting components are present in extremely small amounts and diluted with a very large volume of air; they often must be concentrated considerably before even gas-chromatographic analysis can be effectively utilised. One simple collection method that has been used successfully for studies of the more concentrated components is to inject several millilitres of expired air directly into the gas chromatograph. The presence of ethanol can be detected in normal breath by this method. A more effective method, useful for components in much lower concentrations, involves low temperature condensation using small glass bottles cooled in liquid nitrogen (Figure 3). All components of the breath are effectively condensed in the bottle at this temperature and, upon quickly warming back to room temperature, a highly concentrated water solution of the constituents is obtained, which may then be injected and analysed in the gas chromatograph.

Components in breath.—Normal human breath analysed by this procedure contains several interesting components, a few of which are shown in Figure 4. Among these are two that might well be expected, acetone and ethanol.

Acetone, in low concentrations, is a normal blood component resulting from non-enzymatic breakdown of oxaloacetic acid, which is a natural part of the tricarboxylic acid cycle for the body metabolism of carbohydrates and also results from the oxidation of fatty acids. Acetone thus is not a normal metabolite but probably represents a by-product resulting from the instability of oxaloacetic acid in the water of the body. The amount found in breath varies considerably during the day (Figure 5), probably as a consequence of varying fat metabolism. After periods of fasting, such as early in the morning, the acetone level is also high. It drops however after strenuous exertion, possibly because the high metabolic rate stimulated by exertion increases complete carbohydrate metabolism. Faults of carbohydrate metabolism such as that seen in diabetes mellitus cause tremendous increases in breath acetone, enough that it and the other ketone bodies associated with it can be smelled on the breath.

Ingestion of isopropanol, an alcohol that is converted by the liver to acetone, causes spectacular rises in acetone levels illustrating rather well the workings of a human organ. The efficiency of removal of isopropanol is well demonstrated by Figure 6. Before the breath-level of isopropanol can be detected, the body has begun to show its oxidation to acetone by a sharp rise of this compound above normal levels. There appears to be almost complete removal of isopropanol from the blood stream before it reaches the lung circulation. The versatility of this detoxi-

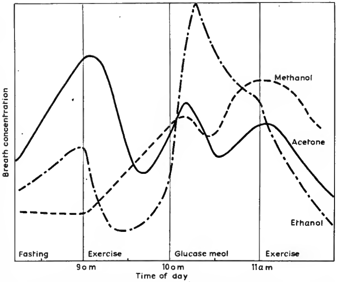


FIGURE 5. *The variation in breath levels for three common components as a function of exercise and a glucose meal. The subject was not controlled before 8 a.m. and thus the initial period, though fasted, was not without exercise. The exercise was vigorous and its effects marked. The rise in breath methanol at 10.30 is normal; this compound shows a rise just a bit later than ethanol after a meal.*

fication process can be shown also by the reverse effect: small quantities of ingested acetone can be partially converted to isopropanol by the body (and demonstrated in the breath) but at a much slower rate.

Ethanol is another normal constituent of the blood and breath, probably resulting from acetaldehyde by oxidation. The main metabolic pathway probably does not include ethanol at all, but only acetaldehyde. Yet the breath level of acetaldehyde remains low, despite the high breath and blood ethanol levels attainable in man; it is likely that the extremely high rate of acetaldehyde metabolism (shown by other means) and the several other pathways of ethanol metabolism prevent a true equilibrium picture from developing.

Both ethanol and acetone are present to some extent in foods and a small portion of the quantities observed undoubtedly arises from this source. The hourly rise and fall in breath levels of these compounds shows definite peaks after meals. Even meals of essentially pure sugar show the same rise, however, so that a dietary source alone does not account for all that is seen.

There are undoubtedly many other compounds present in the breath and blood from time to time, as a result both of diet and of varying states of health. Other compounds have been detected in our work but their relationships to health and diet are not clear-cut enough to report.

One substance, however, requires some mention. In all humans studied we have found evidence for methanol (methyl alcohol) in the breath. The amounts vary from much less than the ethanol level to considerably more. Although the bodily mechanisms for getting rid of methanol are essentially the same as for ethanol, there does not seem to be any discernable relationship between normal-body ethanol and normal-body methanol. Ethanol competes much more efficiently for the detoxification enzymes and if ethanol is given to a victim of methanol poisoning, until the methanol can be excreted unmetabolised, the toxic metabolic products of methanol are not produced and the symtoms of poisoning can be circumvented.

The normal methanol level in the breath rises and falls during the day in just the same way as the other constituents and, as it is also found in foods, tobacco, preserved fruits and liquors, a dietary source undoubtedly contributes part of it. It is, however, not solely dietary in origin. Its level after overnight fasting is much too high for this explanation, and we have suggested a metabolic source, even though there is no apparent biochemical reason for the presence or formation of methanol by normal mechanisms.

It must also be borne in mind that some or all of these constituents (acetone, methanol, and ethanol) might be formed by intestinal bacteria. While this may well occur and therefore contribute to the observed results, the wide racial and dietary variation among the subjects we have studied, all of whom show these same three compounds, suggests that either there is one common intestinal factor or, as we have suggested, methanol is indeed a product of general metabolic action.

Our work in this area is not completed. Even from this quick glance, it should be apparent that there are many gaps yet to be filled. The results so far are exciting. We believe that the breath is a powerful tool for probing the body's inner secrets on a level not previously attainable and, coupled with the powerful gas-chromatographic separation and identification methods, one should be able to study the body functions on a metabolic or enzymatic level, directly in the normal human body.

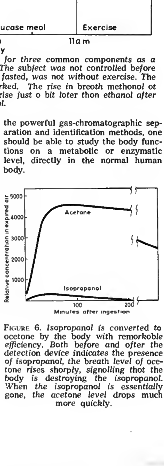


FIGURE 6. *Isopropanol is converted to acetone by the body with remarkable efficiency. Both before and after the detection device indicates the presence of isopropanol, the breath level of acetone rises sharply, signalling that the body is destroying the isopropanol. When the isopropanol is essentially gone, the acetone level drops much more quickly.*

How to spot a satellite

Twenty artificial satellites can be seen by the naked eye. Equipped with a stopwatch and a star atlas, the amateur can make scientifically useful observations of their orbits

by J. A. Pilkington
London Planetarium

The brightest artificial satellite, Echo 2, undergoing ground tests at Lakehurst, New Jersey, before launching. The satellite is 135 ft in diameter.

MILLIONS of people throughout the world have spotted the *Echo 1* balloon, the brightest of the artificial satellites, as it orbits the Earth, but many other satellites have been seen by an unsuspecting gaze skyward. Already there are about 400 spacecraft, rocket bodies and assorted fragments circling our planet. Twenty of the larger objects can be seen from Britain by the naked eye, and a further sixty are discernable through binoculars.

The bigger and more numerous the Earth's youngest attendants become, the more will their appearance begin to rival even the brightest of Nature's stars and planets in the sky. There only remain about a dozen stars brighter than *Echo 1*, and only half a dozen superior to the brilliance of *Echo 2*. If a 750-ft inflated sphere were put into orbit 1000 km high it would be a magnitude −4.4, equal to the planet Venus at its maximum, and the most prominent object above our heads apart from the Sun and Moon.

Most satellites travel round the Earth in an easterly direction, taking at least 87 minutes and sometimes several hours for one revolution. The inclination of an orbit is the greatest latitude the object reaches north or south of the equator. People in Britain therefore see a 50°-inclination satellite travelling roughly from the western to eastern horizon, and a polar one from the north to south (or vice versa). The satellites move fast against the background of stars, taking from six to twenty minutes to pass from one horizon to the other.

Only one or two spacecraft have ever carried their own lights, and so we only see satellites when they are themselves in sunlight but are passing above a part of the Earth which is in darkness. A satellite is not, however, seen to cross the same part of the sky at the same time every night. The Earth's equatorial bulge and other imperfections cause almost all orbits to drift westwards in space and to cross any country earlier each day. Thus satellites have visibility cycles, firstly being seen in the mornings, then about midnight (if they are sufficiently high to be above the Earth's shadow), and finally in the evenings. They are then invisible for a few weeks while their passages traverse the daylight hours. The shortest visibility cycle possible is 33 days long and the longest virtually infinite. *Samos 2* is an example of the latter; it will always pass over Britain about 11.0 p.m.

A few unusual satellites in orbits which are even more inclined against

TABLE OF NAKED-EYE SATELLITES

Inclination (deg)	Direction of travel	Satellite	Period (min.)	Height (km)	Magnitude (low numbers, bright; high numbers, faint)	Remarks
35° or less	low in south	—	—	—	—	**Midas 2, Cantaur 2, Saturn 5** naked eye from low latitudes only. **Explorers, Vanguards** fainter.
39.0	SW to SE	**Explorer 9**	108	1150	6.4 steady	Re-entry due May 1964. Also **Telstar 1 and 2** in 44° orbit very faint.
47.2	WSW to ESE	**Echo 1**	114.7	1445	0.9 steady	Est. life 15 yr. 66 min earlier daily. Also **Relays** very faint.
47.9-48.6	" "	**Tiros 1-4**	98.0-101.3	610-950	8.3 steady	Bright flashes every 2 secs. to +3 magnitude.
49.0	SW to SE	**Cosmos rockets**	92-95	375-525	2.3 to 3.8 flickering every ½ sec	Short life. **Cosmos rockets 17 and 23** still up. **Cosmos satellites 11, 17, 19, 23** mag +5 steady.
50.1	W to E	**Anna 1B rocket**	107.5	1115	4.4 to 6.8	Slow variation. **Anna 1B** mag. + 7½.
52.0	"	**Explorer 16**	104.3	965	3.6 to 7.6	Flash every 2½ secs. **Transit 1B, Explorer 7, 8, Cecsat** mag. 6.3 to 8.5 flashing.
53.8	WSW to ENE WNW to ESE	**Ariel 1**	100.6	785	5.7 to 8.2	Flash every 2 sec.
58.1-58.5	" "	**Tiros 5-8**	97.3-100.4	580-970	7.4 steady	Bright flash every 3 sec. to +3 **Explorer 17, Polyot 1** fainter.
65.0	SW to NE NW to SE	**Sputnik 4 cabin**	91.5	350	3.4 to 4.9 fading	Re-entry due Nov. 1964. **Vosteks, Cosmos, Sputniks** bright.
66.7	" "	**Transit 2A rocket**	101.4	822	4.5 to 7.4 slow fade	**Greb 1, Transit 2A, Transit 4A** belt fainter.
70-76	" "	**Discoverers**	90-93½	250-450	0 to 3	Flashing or steady. Short life.
78.6	SSW to NNE NNW to SSE	**Explorer 19**	115.9	1490	3 to 8 steady	Brightness depends on height. Est. life 5 years.
81.5	" "	**Eche 2**	108.9	1025	−0.4 steady	Brightest satellite. 24 min. earlier daily. Est. life 5 years. Rocket +5, flashing.
80.5	" "	**Alouatta rkt**	105.5	1015	3.1 to 6.5	Flash every 6 sec. Also **Alouetta** satellite +4 flashing.
81.9	" "	**1963-03A**	94.5	490	2.9 to 6.5	Flash every 2 sec.
82.3	" "	**1963-27A**	94.7	500	2.8 to 5.3	Flash every 1 sec.
82.8	" "	**1962 A-Upsi**	92	385	2.6 to 5.4	Re-entry due Sept. 1964. Slow variation.
89.9	S to N	**1963-38A**	107.1	1088	4½ to 7	**Ablestar rockets.** Also **Transit 5A, Transit 1963-22** fainter.
90.0	N to S	**1963-49A**	106.8	1075	slow fade	
97.4	SSE to NNW +NNE to SSW	**Samos 2**	94.7	500	3.8 to 6.1 fading	Orbit over Greenwich same time each day, 12.15 GMT southbound and visible 10 pm to midnight, northbound.

Note: **Midas** satellites (153-168 min; 87-96°) are also visible over Britain at magnitude 5½ to 8½, slowly varying. Many faint objects have been excluded from this table. The brightest stars are about magnitude −1; the faintest visible to the naked eye about magnitude 6.

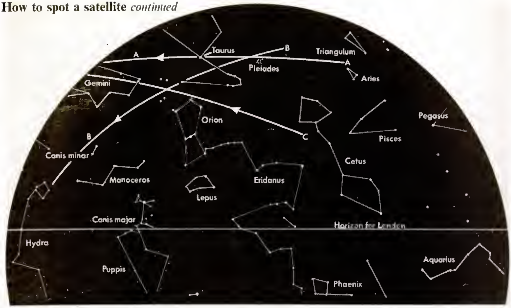
the Earth's equator can actually have passages becoming *later* each day. Some spacecraft in nearly polar orbits, the US *Discoverer* series for example, may occasionally be seen in both the mornings and evenings, moving in opposite directions. In winter, the hours just after sunset or just before sunrise are best for satellite spotting, while in summer, especially in Scotland, midnight is the only time the sky appears dark enough to see anything.

It is obviously not practicable to give here the time and place to look for all satellites on all occasions. Suitable predictions are rarely available in popular or technical journals, although the *Daily Telegraph* gives information on *Echo 1* and *Echo 2* below its weather map whenever they are visible from Britain. *Electronics Weekly* also publishes a timetable for anyone who may wish to receive radio signals from about a dozen transmitting spacecraft.

The casual observer can only hope to see satellites other than *Echo 1* or *2* by accident, guess their identity, and search for them the following night. If, for example, a newly-launched *Sputnik* is sighted, and one learns its orbital period from the press or radio, one can work out how many minutes later it will appear each day by dividing 1440 by the orbital period in minutes. The whole number and remainder obtained show the revolutions and time change per day. Satellites taking over 93 minutes for one revolution about the Earth may sometimes be seen twice on one night on successive orbits. The accompanying table, describing some of the naked-eye objects and their apparent direction of travel as seen from Britain, may assist the casual observer in interpreting what he sees.

It is not generally known that anyone can make simple satellite observations of real scientific value with very

How to spot a satellite *continued*



A panorama of the sky as it will appear looking southward on the Greenwich meridian at 16.45 GMT on 7 March 1964. (A) Echo 1: *19.10-19.20 GMT passing* close to Beta *Taurus* and Beta *Gemini. (B)* Echo 1: *21.15-21.25 GMT passing* close *to the Pleiades and* into eclipse *in Hydra. (C)* Geosat: *21.42-21.48 GMT passing* close to *Alpha Taurus* and *Beta Gemini. (Although the sky will have moved farther* to the west *by these times, the tracks* are *shown* against *the correct background stars.)*

little equipment. A stopwatch reading to 0.2 second, access to radio or telephone time signals, and a moderate star atlas such as Norton's are the basic necessities. Although spotting can be done without optical aid, most amateurs use a good pair of binoculars or an "elbow" telescope with a field of about 5°. As an individual's experience and enthusiasm grow he can acquire more elaborate equipment—perhaps a reliable chronometer accurate to a few seconds per day to eliminate continual reference to time signals, or alternatively, a short-wave receiver tuned to 2.5, 5, 10, 15, or 20 Mc/s to pick up the time pips of MSF or WWV. A small reflecting telescope (field at least 2°) will show faint objects and Becvar's Atlas Coeli or Ellipticalis will identify reference stars down to 9th magnitude. Those observers who own tape recorders can obtain 20 or more positions per passage by counting down timings and describing the satellite's track for subsequent identification, although timings must be corrected for tape stretch. Using these methods the best of Britain's amateurs have totted up 11 000 observations on 100 satellites during 1963 alone. A minority of them use cameras with a rotating shutter to provide several positions on one photograph, and others measure the satellite's altitude and azimuth with a theodolite which has been previously levelled and orientated. Both these techniques are usually too expensive and time-consuming for anyone except at a professional kinetheodolite station.

A satellite observation merely consists of the position the object occupies against the background of stars at a particular instant. The stopwatch is pressed at the moment the satellite crosses the imaginary line joining two stars, and the position estimated as a fraction of the separation of the stars. The closer the reference stars, the more accurate the observation, although estimates can be made of the satellite's closest approach to a single star. A complete observation includes the probable accuracy of time and position, and the object's stellar magnitude and period of flashing if noted.

All observations made in Britain are normally sent to the DSIR Radio Research Station, Slough, where a small prediction service is housed. The service, not available to the general public by reason of its limited size, distributes data on about 40 spacecraft to a hundred serious amateur stations throughout Europe, and catalogues the returned positions for use by space research workers of any nationality. Far from duplicating the effort of other countries, the service and its network of tracking stations is able to complement world-wide optical coverage when satellites are invisible to both the American and Asian continents.

The importance of the amateur satellite tracker gazing skyward from his suburban back garden, stopwatch in hand, is perhaps not immediately obvious. But he is, in his small way, contributing to the accurate determination of one more satellite orbit which, compared with other orbits, can assist the professional scientist in obtaining a greater knowledge of our environment—the density of the Earth's atmosphere, the pressure of solar radiation, and the gravitational forces of the Earth, Sun, and Moon. In some cases he will know that the faint point of light racing across the sky will still be there for his descendants to see, a thousand-year monument to the pioneers who put man's first footprint amongst the stars.

Trends and Discoveries

The fall that caused Rome's decline?

GEOGRAPHICAL CHANGES on a number of occasions have demonstrably altered the course of human history. Sixty years ago R. T. Gunther pointed out, from observations in the Bay of Naples, that the Italian coastline showed evidence of historical changes of sea level. He suggested that towards the end of the Roman Empire low-lying regions, such as the Pontine Marshes and the Plain of Paestum, near Naples, may have been depressed sufficiently to have become extensive swamps. A resulting increase in malaria could have contributed to the Romans' decline.

In *Nature* (Vol. 201, p. 909) Dr Gunther's son, A. E. Gunther of London, describes further observations made last autumn which lend support to the idea. Not only did he find ancient shore levels on the Calabrian coast up to 60 feet above present sea level but also unequivocal evidence that these changes occurred in historical times.

The Plain of Paestum contains three Roman temples. In 1930 G. de Lorenzo, professor of geology at Naples, proposed that the plain had sunk, reaching its lowest point during the Middle Ages, and had subsequently risen again. Gunther's new evidence is in the form of borings made by the marine mollusc *Lithodomus*. They occur in the columns of all the temples up to heights of five feet from the floor—or 61 feet above present sea level.

Altogether he estimated that the temples may have sunk 76 feet and risen 61 feet since Roman times. This time-scale may apply to other examples of 60-foot ancient shore levels extending as far as Sicily and Malta.

New calculation weakens Earth expansion theory

RECENTLY A Dutch geophysicist made a calculation, based on the evidence of "fossil" magnetism in rocks, which, he claimed, showed that the Earth's radius may have increased by as much as 20 per cent since the Devonian Period 300 million years ago (*New Scientist*, Vol. 21, p. 99). He found, however, that the evidence for the European-Russian landmass was not consistent with this idea unless one postulated "tears" in the continent caused by the expansion of the Earth.

M. A. Ward, of the Australian National University, Canberra, has now done a similar computation of past radius from rock magnetism measurements made on a larger number of samples of the Devonian, and younger Permian and Triassic, formations of Europe and Siberia (*Geophysical Journal*, Vol. 8, No. 2, p. 217). He finds that within the experimental error there is no reason to suppose that the Earth has expanded or contracted since these rocks were formed.

He used a generalised statistical method of finding the most probable Earth radius, working out the answers on a digital computer; he got values of 1.12, 0.94 and 0.99 of the present radius respectively for the Devonian, Permian and Triassic. However, a statistical test applied to the Permian results indicated that only changes of radius bigger than 20 per cent of the present value would be detectable using the data to hand. Excluding the hypothesis of continental tears his result nevertheless disposes of the possibility of an expansion of the radius by as much as 45 per cent as has been suggested, for instance, by S. W. Carey of Australia.

Finding the density of the heaviest water

NORMAL WATER contains not only H_2O but also the oxides of the heavier isotopes of hydrogen, deuterium and tritium, which are respectively two and three times as heavy as normal hydrogen. Recent research in America has completed the density determination of the heaviest of these forms of water.

Deuterium is a stable isotope present to the extent of about one part in 7000 in natural hydrogen. Tritium is unstable and has a radioactive half-life of just over 12 years; up till 1952 it was present in normal hydrogen only as a result of cosmic ray bombardment but its incidence has increased by a factor of about ten due to hydrogen bomb testing. Its concentration varies very considerably with source, and in water it is present to the extent of one to 300 parts in 10^{18}.

Twenty-five years ago heavy water (deuterium oxide) was a great rarity but now, owing to its use in the nuclear industry, it is a comparatively common material and its properties are well-known. Tritium oxide is, naturally, a different matter; it has to be artificially produced and it is only recently that a sufficient quantity has been made available—two grammes altogether—to allow its density to be accurately determined. The work was carried out by M. Goldblatt of the University of California Los Alamos Scientific Laboratory (*Journal of Physical Chemistry*, Vol. 68, p. 147).

As tritium is a strong beta-emitter the tritium oxide had to be confined to a vessel which could be filled under vacuum and sealed off so as to avoid health hazards. With the first one-gramme sample Goldblatt tried various methods of density measurement (gas evolution due to self-radiation was a problem); he finally decided upon a magnetic float method for the second, purer sample. He made a three-cm long float from thin-walled quartz tubing with a Mu-metal rod fixed to the bottom. He adjusted its density until it was slightly greater than the expected figure for the T_2O and it would just sink. An electric coil was fixed below the tube containing the T_2O; a current passed through it produced a magnetic field which repelled the Mu-metal rod. In this way the apparent density of the float could be decreased by about one per cent. The apparatus was calibrated by using various liquids of known density. Thus when the float started to rise in the T_2O the density could be determined from the coil current.

The maximum densities and temperatures at which they occur are summarised below for H_2O, D_2O and T_2O.

	Maximum density per cu. cm.	Temperature of maximum density °C
H_2O	1.000	3.98
D_2O	1.106	11.23
T_2O	1.215	13.4

Stars as lenses

ONE OF THE well-known predictions of general relativity theory is the bending of light rays passing near to the Sun. Similar bending should, of course, be caused by the gravitational fields of other stars, and S. Liebes, Jr, of the University of Princeton, has pointed out that this will cause every star to exert a lens-like action on light passing near it (*Bulletin of the American Physical Society*, Vol. 9, p. 41).

He argues that when one star obscures another which is more than a few light days further away, the apparent brightness of the pair rises because of the focusing effect of the nearer star. For stars in our Galaxy, increases of up to a thousand times or more are possible.

He estimates that a tenfold rise in intensity should occur for some pairs of stars in the Milky Way about once per year and should last for about a month or two.

A further rare manifestation of the gravitational lens effect might be the appearance of luminosity in a cosmic dust cloud as it intercepts a slender focused beam of light produced in this way—a sort of cosmic "sunbeam".

Trends and Discoveries *continued*

Metal clips help to show how the heart works

MEDICAL SCIENTISTS have been showing an increasing willingness to use human subjects—and particularly patients—as experimental material. The tendency has progressed further in the United States than in Britain. One of the latest human experiments to be reported from America involves attaching small metal clips to the surface of the heart as a means of measuring the size of the chambers of the heart under various circumstances (*Circulation Research*, Vol. 13, p. 448).

The work has been described by E. Braunwald of the National Heart Institute at Bethesda, Maryland. When patients underwent operations involving an opening up of the chest, the opportunity was taken to sew three silver-tantalum clips to the surface of the left ventricle, the right ventricle, or both. In experiments on laboratory animals such clips had apparently remained inert and harmless to the heart tissue.

The clips were sewn as far apart as possible in the form of a triangle whose apex lay near the origin of the pulmonary artery in the case of the right ventricle, or near the root of the aorta in the case of the left ventricle. From three months to a year after the operation X-ray cine films were made of the beating hearts. Simultaneous measurements were made of the electrocardiogram, the arterial pulse, pressure changes inside the heart chambers and other values, so that the pictures on the film could be precisely related to the particular stage of cardiac contraction at which they were taken.

Researchers projected the films, frame by frame, and measured the distances between the clips. Because the heart rotates to some extent about its axis when it contracts, it was necessary to make some of the pictures in two planes and calculate the corrections needed to compensate for distortions caused by the rotation.

The studies show that a deep intake of breath will increase the size of the right ventricle by an average of 12.5 per cent, since the reduced pressure in the thoracic cavity which accompanies inspiration causes extra blood to flow from the veins into the chest and heart. Light exercise causes a reduction of 5.0-6.5 per cent in the size of the ventricles at both the beginning and end of contraction; it suggests that the extra quantity of blood pumped out by the heart during exercise is the result of an increased rate and vigour of contraction, and a more complete emptying of the chambers, not of a greater filling of the ventricles during relaxation.

Did all Protozoa once reproduce sexually?

MANY SPECIES of unicellular animals (Protozoa), often comprising whole orders, seem to have no sexual form of reproduction, replacing themselves by simple division. Although it is difficult to prove such a negative assertion, especially in biology, many of these species, such as *Amoeba proteus*, have been closely studied for many years, over hundreds of generations, without any indications of sexuality. This raises the question of whether it is a secondary characteristic, asexual species having been derived from ancestors showing sexuality. The latter hypothesis is favoured by R. S. J. Hawes, a zoologist from the University of Exeter (*Quarterly Review of Biology*, Vol. 38, p. 234).

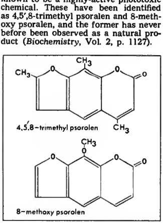
He points out that sexual forms are either common to all members of the major Protozoan groups, such as the parasitic Sporozoa, and the Ciliata, or are discontinuously distributed, being absent from more primitive, and present in more specialised, species. Although this can be explained in terms of the independent evolution of sex on different occasions by different types of organism, it would imply that both the physiology and behaviour patterns needed for fertilisation, and the division and recombination of chromosomes within the cell nucleus associated with sexual reproduction, have simultaneously appeared several times. It is simpler to postulate that all single-celled organisms were at one time sexual, but that this form of reproduction has been abandoned by certain groups. This would be a more plausible hypothesis if cases of deterioration of sexuality among present-day Protozoa could be demonstrated.

Evidence has been found that several species of the Flagellate group living in the gut of a wood-eating cockroach, *Cryptocercus*, reproduce asexually, but are stimulated to undergo sexual reproduction by the cockroach moulting hormone. Various sexual processes occur, but while some species appear to undergo sexual reproduction, the characterstic chromosome recombinations do not occur. In *Urinympha*, for example, the number of chromosomes in the cell is halved by simple pairing and segregating. Two daughter nuclei are formed, but the cell does not divide, and the daughter nuclei recombine to form a nucleus containing the original number of chromosomes which is identical to that of the parent. The species lives in a stable and specialised environment, and thus appears not to need to retain the possibility of chromosome variation. There is here an indication of how and why asexuality could have evolved, but to settle the question definitely, more information is needed about the ecology of the asexual Protozoa. Then it may be possible to understand either how, with no more that genetic mutation to supply them with variation, they continue to cope with changes in their environment and survive, or to establish that the asexual species tend to inhabit stable environments.

Blisters from diseased celery

THE FUNGUS *Sclerotinia sclerotiorum* causes a disease known as "pink-rot" in domestic celery. Thirty-one years ago, the blistering found on the exposed skin of celery-harvesters was correlated with "pink-rot" disease in the plants, although the cause of the irritation was not known. Recently it was shown that the diseased portions of the celery contain a product which, on contact with the skin in the presence of sunlight or ultraviolet radiation (wavelength 3650 angstroms), causes the characteristic symptoms.

A group of research workers at the US Department of Health, Education and Welfare, Division of Occupational Health, Cincinnati, Ohio, has succeeded in isolating from 15 kilograms of diseased celery two active compounds belonging to the furanocoumarin (psoralen) group—the psoralen nucleus is known to be a highly-active phototoxic chemical. These have been identified as 4,5′,8-trimethyl psoralen and 8-methoxy psoralen, and the former has never before been observed as a natural product (*Biochemistry*, Vol. 2, p. 1127).



4,5′,8-trimethyl psoralen

8-methoxy psoralen

The two compounds may be natural constituents of the fungus, or metabolic products formed as a result of its growth on the celery plant. The researchers are now trying to gather information on phototoxic effects caused by the fungus growing on other plant species, as further data are essential to the understanding of the special relationship between the celery plant and the "pink-rot" fungus.

Ultrasonics to treat the short-sighted

AN ULTRASONIC hand instrument is proving effective in treating acquired (as opposed to hereditary) myopia. The present version of the device, developed jointly by Y. Yamamoto of the Ophthalmic Department, Tokyo Metropolitan Hospital, Komagome, Japan, and researchers at the Shibaura Technical University, has been used in clinical trials for the last year at Komagome.

The action of the instrument on the eye is thought to be a form of micro-massage by the ultrasonic waves. Heat generated by the vibrations may act on the retina, stimulating the blood circulation. The waves may also help to relax the focusing muscles of the eye lens. The novelty of the treatment is claimed to lie in this dual action on both the front and back regions of the eyeball.

Of the 220 cases of acquired short-sight so far treated by this method, about 60 per cent have shown significant improvement. However, the more acute the myopia, the less amenable it is to treatment. Children react most rapidly, and the best results have been obtained with those under 12.

Why some plants eat insects

THE INSECTIVOROUS HABIT of such plants as the sundew, butterwort and pitcher-plant has been suggested as being an adaptation enabling them to live on soils deficient in nitrates and other mineral salts. This theory has been tested recently in an area of sandy soil in the Middle Coastal Plain of the United States, by G. L. Plummer, a botanist from the University of Georgia (*Ecology*, Vol. 44, p. 727).

Chemical and productivity analyses of the soils from the two areas showed that the overall level of plant nutrients in the soil was low, being hardly enough to support the dense vegetation found there. Plants probably survive because of the slow release of nutrients from decaying remains of previous growth. Also it is thought that the perennial species may have some way of conserving essential elements and relocating them within the tissues, and that the inflow of soil water may carry a supply of soluble nutrient material.

Both habitats are especially low in calcium, potassium and magnesium, and though organic matter and water are plentiful throughout the year productivity declines gradually. This would lead to competition for the limited minerals and suggests that the insectivorous plants may, in this case at least, benefit more from the metallic ions in their insect prey than from the nitrogenous compounds.

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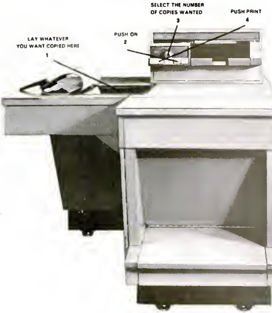
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AND IF YOU READ MAGAZINES BACK TO FRONT YOU'LL FIND OUT WHAT IT'S ALL ABOUT OVERLEAF

LETTERS

Oceans in 1984

Sir,—The article "A long view from the beach" (by Dr Roger Revelle, 20 February) made interesting reading, but I was most alarmed at the method he suggested for preventing hurricanes, viz. by inhibiting insulation over vast areas of the Western Atlantic and Indian Oceans.

Even though the experiments would be conducted "under the auspices" of world organisations, one cannot help feeling that the article exhibits much more concern with the creation of some American dream or (integrated?) Utopia in the State of California, than with the wider implications of scientific development.

While I admit the necessity of making hurricanes things of the past, Dr Revelle's method of preventing them seems, if not risky, at least full of many doubtful aspects. Confining ourselves to the Western Atlantic, it would be interesting to hear Dr Revelle's ideas on the probable effects of this temperature control of the waters of the tropical Western Atlantic, on the climate of those countries whose shores would be washed by the then cooler waters of the North Equatorial current. Who will determine what is "more than the usual amount of solar energy", or will the artificial cloud cover over a million square miles be so controlled as to ensure a not-less-than-usual amount? Would the temperature of the Florida Current and possibly the Gulf Stream not be affected, and would temperature and density changes not have far-reaching effects on the zoo-plankton organisms in these waters? And what effect will the cooler, not-so-humid NE trades have on the climate of Venezuela and the Guianas? These and other questions would need very careful consideration before we attempt scientific experiments, which from one point on our globe appear to offer nothing but advantages.

R. WESTMAAS.

110 Windermere Road,
London, w5.

Do woodlice carry their own hygrometers?

Sir,—A direct approach to the study by surgical means of hygroreception in woodlice is indeed made difficult by their poor resistance to operation as mentioned in Professor J. L. Cloudsley-Thompson's letter (30 January). Whilst woodlice lend themselves to being used in straightforward observational tests they do not readily survive experimental piercing of the body wall.

In the course of behavioural experiments (*Animal Behaviour*, in the press) I have found a correlation between the degree of immobility induced by coming into contact with solid objects (thigmokinesis) and the relative humidity. (Although woodlice respond to saturation deficit of the air rather than to relative humidity, the use of RH as a measure is permissible if experiments are confined to a narrow temperature range.) Woodlice often come to rest in confined places such as crevices, and I showed that such behaviour varies with humidity though it is not caused by it alone.

It seems likely that the receptors responsible for thigmokinesis include mechano-receptors in the form of bristles which are numerous on the body surface, but straightforward methods of amputation or gross covering gave inconclusive results, and delicate techniques are required.

There is another possibility, namely that proprioceptors are involved. Loss of water by evaporation will affect not only the salinity of the blood but also its pressure. In dry air the pressure must be reduced and under such conditions the woodlice are readily immobilised by contact; in moist air the pressure will be high and the contact immobilisation is much less pronounced. When it squeezes into a crevice the woodlouse is compressing its body cavity and the consequent pressure changes on internal structures may produce conditions analogous to those which exist at high humidity and lead to similar behaviour.

It seems possible then, that receptors sensitive to changing conditions of internal pressure may be involved in the response to both humidity and contact.

C. P. FRIEDLANDER.

Chelsea College of Science and Technology.

The cost of smoking

Sir,—The remarkably high estimate of 13.4 years mean loss in expectation of life for boys now aged 15 who will be cigarette smokers, shown in the *Social Balance Sheet* for smoking (6 February), cannot include more than quite a small fraction which is due directly to lung cancer.

Since about one in ten men smoking more than 20 cigarettes a day now die of lung cancer, if their mean age at death was 55 (almost certainly an under-estimate), and the mean expectation of life for a male aged 15 is taken as 60 years (probably an over-estimate), then one heavy smoker in ten may stand to lose on average upwards of 20 years of his life, which is a mean loss of two years for all heavy smokers from the risk of lung cancer. As this is likely to be an over-estimate, and as moderate smokers are at a considerably lower risk, it seems unlikely that the mean loss for all male smokers due to lung cancer alone, should much exceed one year out of the 13.4 years claimed as the loss in expectation of life from all causes associated with cigarette smoking.

C. B. GOODHART.

Gonville & Caius College,
Cambridge.

Man-powered flight

Sir,—In your note *Man-powered flight prize may soon be won* (13 February) you print an excellent resumé of my recent talk before the Royal Aeronautical Society on this subject.

There are, however, two errors which I feel I should mention. First, I am not chairman of the society's man-powered aircraft group, but vice-chairman—Mr Robert Graham, who chaired the recent meeting is the chairman. Second, the two-seater designed in Ottawa under the aegis of the Canadian Aeronautics and Space Institute was not designed by Haessler, but by Czerwinski. Haessler has re-designed his prewar Mufli, but he lives in Toronto and it is a single-seater.

B. S. SHENSTONE.

Weir House,
Belweir Park,
Hythe End,
Nr Staines.

Space probe to sample comet

Sir,—I was very interested to read under the above title in "Trends and Discoveries" (30 January) of the report in Science et Avenir concerning a probe to the comet, Encke.

I have been investigating this very problem since late 1962 and discussed the concept with a representative from the Space Center of Radio Corporation of America in September 1963. The reasons I have not published my investigation atem from my conviction that little would be achieved by a probe at the forthcoming helion.

I disagree with the suggestion that it is possible at this late date to conceive and engineer a probe for interception in July 1964. The lead times for such an undertaking are long, and, unless NASA have been carrying forward such a project with little publicity, there is not sufficient time.

I feel a more valuable suggestion for the next helion would be a radar contact experiment. This would provide a more difficult task than the Mars/Venus contacts and, if achieved, would assist with orbit determination. It is also possible that interesting echoes may be returned from the head. This experiment would pave the way for a well-planned rendezvous in late 1967.

For immediate investigation Encke is the most interesting as it alone appears to suffer retardation with ensuing acceleration. It is a short period comet and would appear to provide an ideal subject for continuous surveillance by probes over an extended period of time.

A longer term alternative is Schwassmann-Wachmann 1 which moves round the Sun between Jupiter and Saturn with an orbital eccentricity of 0.132. It may be observed annually and is interesting for a number of reasons. Unfortunately, present tracking and satellite technology make this impracticable in the distances involved. Both Mors *I* and Moriner lost Earth lock at extreme range.

The ultimate in comet probes must surely be the investigation of Halleys Comet on its return in 1986. All comet probes should build up expertise to culminate in an investigation of Halley on its next helion.

As Encke was used by Backlund and von Asten to weigh Mercury and Jupiter, it would be most appropriate to measure the perturbation of probe and comet to weigh this comet.

There are a number of reasons why a probe to Encke should be deferred until the next helion. The change in secular acceleration due to retardation is not regular and the changes occur at periods of sunspot maxima. A probe at the present period of sunspot minima would not be so productive as a probe at the following helion when solar activity is on the increase. The size and brightness of the comet head varies with this cycle, increasing the value of an experiment in 1967.

A rendezvous in late 1967 would allow the use of a larger payload. This may be used to provide greater instrumentation, but could also include a propulsion package to effect an orbit plane change at the node and bring the payload into the plane of the comet's orbit. In this way an interception could be arranged to occur when the comet was experiencing retardation and when observation would provide the most interesting results. This occurs in a narrow region not far from perihelion.

As discussed earlier, interception may be either in the plane of the ecliptic or in the plane of the comet orbit and close observation may be attempted by photography followed by a slow scan as with *Lunik III*. Additional experiments may concern measurements of solar wind and magnetic fields during the retardation period. In order to sample a large volume of the head, a number of small sampling devices may be ejected from the probe before interception. Some method of observing rotation of the nucleus, possibly by a radar experiment, should also be employed.

I do not have financial sponsorship for my studies, however if any readers would find interest in cooperating on this or similar astronautical projects,, perhaps they would communicate at the address hereunder.

P. A. E. STEWART.

11 Fairhaven Road,
Redland,
Bristol 6.

COMPANY MEETING

Borax (Holdings) Limited

LORD CLITHEROE'S REVIEW

The following are extracts from the review of the year tb the 30th September. 1963, by the Chairman, The Rt. Hon. Lord Clitheroe, P.C., to be presented at the Annual General Meeting on Wednesday, 25th March, 1964:—

World sales of boron products reached a new record level for the second year in succession. Business in the U.K. and Northern Europe was strong in the second half of the year. The earnings of our American operating subsidiary, United States Borax & Chemical Corporation, were the highest yet achieved; during the year their cost reduction programme was continued, and this helped to no small extent to offset the wage and salary increases that had to be met as well as the higher prices of goods and services purchased.

The first bulk shipment of our borates was made from Los Angeles to Rotterdam in November 1963. Despite delays caused by the exceptional winter last year, construction of the terminal facilities at Rotterdam will soon be completed and it is expected that regular despatches from the Depot will begin in the spring of 1964. This project is intended primarily to strengthen the Company's competitive position and to improve service to our European customers.

Our aim must always be to safeguard ore reserves for the long-term future. During the period under review we have made additions both on the American Continent and in Turkey where, as I mentioned last year, a promising new mineral deposit was being developed; this work continues and our expectations have been confirmed.

Group profits, before taxation, amounted to £4,168,000 against £3,720,000 in 1962. After providing for taxation and after deducting the interest of the minority shareholders in subsidiaries, the net profit was £1,756,000 compared with £1,645,000 in 1962. Your Directors recommend an increase in the final dividend payable in March of 1% to 10% (less tax) making, with the interim dividend of 5% paid last September, a total distribution on the deferred ordinary stock of 15% (less tax) compared with 14% last year.

Your Board and Management have no reason to alter the views previously expressed that the expansion of your business will continue over the years. At the time of writing this review three months of the present year have passed, and I can report that sales have been satisfactory and profits are somewhat better than last year.

Further study has been made of the potential profitability of potash operations both in Canada and at Carlsbad (New Mexico) and we are re-examining the possibility of a Canadian potash venture of sufficiently smaller scope than previously contemplated, to avoid the legal obstacles thought to stand in its way.

Sixth form books

Wonderland revisited

by D. Taylor Smith

The Earth Sciences. By Arthur N. Strahler.

Harper and Row, New York, xii + 681 pp. 75s.

ONE CHRISTMAS in the early 1930s I was given a massive tome called, if my memory serves me correctly, *The Wonderbook of Knowledge*. It was American and consisted of a compilation of reprints of all sorts of neo-scientific papers culled from innumerable sources. Nearly all my early scientific thoughts were generated by this book: I could dip inside its covers and read such papers as *How to build a high-altitude rocket*, or *The monorail: the travel of the future*, or again, *Now is the time to dissect Bunny* (I still have the bones!). It was all most delightful and as a small boy I never ceased to get enjoyment from it. Now, almost in scientific middle age, it is pleasant to record that I have recently been equally delighted, and in an identical manner, by just such another book: *The Earth Sciences*.

HUMAN SENSES AND PERCEPTION
G. M. WYBURN
R. W. PICKFORD and
R. J. HIRST
The purpose of this book is to make readily available to the biologist, psychologist or philosopher the information concerning those aspects of the contributions of the senses to human experience which are normally outside his special interest.
45s.

PHYSICS IN THE SIXTIES
Edited by S. K. RUNCORN
'A readable and exciting little work'—*Nature* 21s.

ATOMIC PHYSICS TODAY
OTTO R. FRISCH
'Should be read by both physicists and other scientists, and also by the adult layman'
25s. *Nature*

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The arrival of this on the scientific scene is timely. At the present moment many a British university is considering synthesising the efforts of similar sections in various departments (geology, physics, mining, civil engineering, etc.) to form, say, a School of Earth and Planetary Sciences. Some have already done so. Most certainly this is the direction of university thought in America: the successful collaboration of many disciplines towards a common end. Professor Strahler's book, therefore, provides a useful and extremely readable contribution to the discussions.

Not that it has high academic pretensions: almost everything in it has been said equally well, and oftentimes even better, in many other text-books. The author himself stipulates that it is useful only up to early undergraduate level in American universities; with British early specialisation to consider, I would put the general level at the Upper Sixth. But even with this stipulation, this is just about the first text-book to bring all the various parts together and to present them in a simplified non-mathematical way. For this alone it should be praised. It really is a *Wonderbook of Knowledge*, circa 1963.

The book is divided into four, roughly equal parts. Part I deals with the Earth as a part of a planetary system, but having its own particular characteristics: its own gravity field, magnetic field and so on. The second part concerns itself with that which is above the surface of the Earth—air, water and ice—and the effect of variable circulation patterns on the climate. The next, the largest part in terms of pages as befitting its contents, is titled *The Solid Earth*. At the general level of this book, this is very well-described and covers all aspects from the microscopic examination of rocks and minerals to the large-scale oceanographic measurements to determine the structure of the Earth's interior. As one interested in this particular field, I must admit to a certain element of horror at the somewhat naive précis of the theories of Continental Drift, but to keep the size of the section to a minimum I imagine this was unavoidable. The last major part of the book is devoted mainly to the author's own personal interests—geomorphology—and is called *Landscapes and Soil*. Without wishing to complain too bitterly to such an authority as Professor Strahler, I should like to make the comment that the impression gained by this section is that geomorphology is still the static, descriptive science that it was ten or twenty years ago. To make no mention of the present-day quantitative measurements, and to introduce pedology but to leave out soil mechanics (or does he assume that the one includes the other?), completely mar what should have been from his point of view the climax of the book. The work ends with a series of peculiar appendices: these deal with map projections, equal value maps (i.e. contour maps—topography, gravity, magnetic, etc), geological maps and sections, and conversion tables. These may have a certain value in schools, but would be out of place in a university text-book.

The book is beautifully written and adundantly illustrated and can be understood by almost anyone. It deserves a place in every school reference library; it could do no harm in universities.

D. TAYLOR SMITH.

Profiles in science

Ivan Pavlov. By Hilaire Cuny.
Robert Oppenheimer. By Michel Rouzé.

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Pavlov was a most attractive, straightforward, extrovert personality, but shrewd. He accommodated himself to the Russian revolution because he was a patriot who never forgot that the revolution was Russian as well as revolutionary.

The difficulty in writing on such a subject as Dr Robert Oppenheimer at the present time is that political conflict restricts the publication and assessment of the facts. M Rouzé says that Robert Jungk's *Brighter than a Thousand Suns* "has been one of the sources of information for the present volume". In his review of Jungk's book, Sir John Cockcroft, who is better acquainted with the facts than most, said that "the book as a whole is interesting, but it cannot be considered as an accurate historical account of these developments". Nevertheless, every intelligent person has to inform himself as well as he can on the scientist's moral and social problems in the atomic age, and must make the best of such information as is available.

Bearing in mind the difficulties which confront writers such as Jungk and Rouzé, and the comments of authorities such as Cockcroft, the present contribution of M Rouzé is to be welcomed as a short, easily-read account of a significant personage of the atomic age.

Oppenheimer's qualities seem to have been more important against the American background than they would have been in Europe. The tendency of American science towards technical specialisation enhanced the value of his general knowledge, which though portentous often does not seem very profound.

The publishers claim to produce "good books in the modern mood". The "modern mood" seems a bit hard on Dr Oppenheimer in the portrait on the dust-cover. He comes out looking like Mephistopheles after a close shave. However, format is a matter of taste.

J. G. CROWTHER.

Life out there

Life Beyond the Earth. By V. A. Firsoff.
Hutchinson, 320 pp. 42s.
Life on Other Worlds. By John Rublowsky.
Constable Young Books, 99 pp. 12s. 6d.

In every age, there arise thinkers whose attitude to the normal, accepted beliefs sets them apart. A survey of Firsoff's many works puts him, I think, into this category; he is not afraid to move in any sphere, and when he does, he comes armed with facts and figures

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which he has vetted to his own satisfaction. He is at once stimulating and provocative.

It is clear from the text of *Life Beyond the Earth* that here we have Firsoff's own attitude to the subject; his view of life both terrestrial and extra-terrestrial. He has divided his book into five parts, the first deals with the question of life in physical and chemical terms and is designed to provide a ground-work of the essential concepts involved.

The second deals with theories of the origin of terrestrial life and this includes extensive treatment of perceptual understanding and mental development. It is here perhaps that the wide range of Firsoff's studies are clearly indicated.

In part three, various environments are discussed in which our type of life might be possible and the alternative organic chemistries which could be deemed possible in other environments. Some of the speculations here might be described as very adventurous.

In part four, the solar system and planetary environment are dealt with and offers an extremely good survey of what is known to date.

"Life in the Universe" is the title of part five and this section covers the possible origin of planets, stars and galaxies and indeed the whole system of the universe is examined. Controversial problems of cosmology as it exists at this date are boldly discussed.

Firsoff marshals his facts and brings forward his proofs, as he sees them, together with supporting references, which are extensive, to each chapter. A comprehensive appendix is included and in it reference is made to certain parts of the text where statements are re-examined in greater detail.

Perhaps the most important result of this book is that it does make one think and re-examine one's own point of view and for the sixth former, on the threshold of the world of science, it will be useful in the formation of opinion. If it does no more than focus a spotlight on the too ready acquiescence to existing lines of thought, it will have proved a valuable contribution to any library. Whether one agrees or violently disagrees with the views put forward, one cannot escape the book's stimulating fascination.

Life on Other Worlds is written in a conversational style and makes quite pleasant reading. At the same time, due regard and credit is given to workers in the various fields under discussion, although in some cases the names are not quite correctly spelt.

The three planets, Venus, Earth and Mars are described as being within the "life belt" of the solar system and a fair amount of text is devoted to this life belt. The information is reasonably up-to-date, though there is no mention of the *Mariner* Venus probe.

The book is divided into ten chapters with a bibliography. The reader is introduced to the subject in a chapter entitled "The Way of Science" and the planets are dealt with one by one, until finally speculations are made as to life in the universe around us.

There are, however, some criticisms to be made. For instance, a chapter is devoted to project Ozma, but this is in many respects out-of-date. It quotes the 600-ft telescope as being on the way to completion, but it is unlikely that this telescope will ever be completed. Again, there are a number of pen sketches and these perhaps mar the book, being very clumsily drawn. Another minor criticism is that the glyphs of the various planets are used to head chapters, but they do not necessarily refer to the text.

Nevertheless, this book is worth reading for those who would like to begin with an introduction to the subject. But then the reader should pass on to something more complete, and perhaps more detailed.

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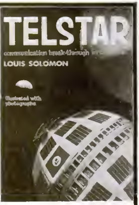

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The Kingdom of Hexapoda

The Amazing World of Insects. By Arend T. Bandsma and Robin T. Brandt. George Allen and Unwin Ltd., 42s.

THE WORD "amazing" in a book title is not calculated to win the heart of a biologist, a naturalist or anyone else who takes a scientific subject seriously. Yet in Bandsma and Brandt's book of insect close-ups, it is perhaps the only false note in a symphony of hexapodal diversity. The photographs are outstanding as this selection shows. To the left is a leaf-insect with an elephant bettle *(Xylotrupes)* below it with the eyes of a robber-fly (Asalidae) and the larva of an Australian Emperor butterfly alongside.

Insects are probably the oldest surviving inhabitants of the surface of the continents. They are also remarkable in appearance and habits. Fleas, for instance, breathe through holes in their sides; they have a nerve cord below the stomach and a heart in the middle of their backs. Other arthropods lay eggs through their elbows, urinate through their heads and regularly practise virgin birth. Students of entomology are apt to forget that hexapods, the six-legged animals with their skeletons on the outside, owe their diversity to four factors: flight, adaptability, skeleton and size. They have been able to conquer almost every dimension of the world's habitats, with the exception of the sea. They are found in untold numbers and, morphologically, this book shows just how diverse they can be.

JOHN HILLABY.

The technologist in our midst

Technology. Edited by Dr J. Bronowski *et al.*
The Macdonald Illustrated Library, 367 pp., 56s.

The increase in specialisation which has taken place in—as elsewhere—science has naturally been reflected in the publishers' lists, and, indeed, for one or two it would seem that the more esoteric the field the better. Plainly they have their reasons; there must be money in it. But one side effect has been a real scarcity of broadly-based science books of quality.

Such criticism, however, is not to be levelled at this volume. Apart from the formidable Dr Bronowski, the editorial board here boasts Sir Julian Huxley, James Fisher and Sir Gerald Barry, and the result is a clear and cogent study of the world of technology, to go alongside the same team's earlier books on *Science*, *Nature*, *Geography* and *History*.

Although the object of the work is similar to that of an encyclopedia, the alphabetic and even the chronological approaches have been dispensed with. Instead, it is arranged so that one subject leads into another. For instance, the reader starts with techniques as basic to science as it is possible to find, namely those of measurement. From this he moves to other basics, power and energy, and on again to a section on the riches of the Earth. All of the facets of technology are dealt with in this way, and the advantages are obvious for anyone who wants a general picture of the subject.

However, for others, who are interested in the specific, there is aid in the shape of a chronological framework of discovery at the beginning, and a comprehensive alphabetic index at the end.

It is heartening to find a work of this kind which takes into account the sociological implications of progress in technology. The final section, "Technology: a summing up", is not only what it purports to be, but forward-looking into the bargain. The social consequences of what is and what will be—for instance, the kinds and amount of work available—are discussed. Of necessity this is only brief, but is handled in clear and responsible terms. For all of us engaged in science this is obviously a matter for hard thought; for the sixth-former, not yet in the swim and, therefore, with a mind perhaps less clouded, it is even more important.

Finally, one criticism: it seems to me that the price of this book puts it firmly into the category of the "present" or the library book, which presumably will restrict sales. True it is generously illustrated and produced, yet a little less gloss would surely have meant a cheaper sale price and greater readership, with due benefit all round. But there we come again, full circle, to the economics of the book trade.

Nevertheless, it is a pity.

PETER WILLIAMS.

A hundred years of plastics

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The Plastics Institute, 130 pp., 25s. (15s. to members).

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That could be nothing else than what we now call a plastic. Parkes was awarded a medal for it but it was only one of the many chemical inventions and achievements of this fertile brain, tutored in the infant rubber industry and experimenting intrepidly in the domestic kitchen. Kaufman describes all this in graphic detail, in fact this early chapter is typical of his book — eminently readable, because it is rooted in human striving and achievement.

In a limited sense, Kaufman is just an editor because he has drawn upon contributions from a number of eminent members of the industry but the Plastics Institute committee which was organising this record decided that they should "go into the pot", so the brew is Kaufman's, the taste and flavour are his. Besides, the whole of the first part, on celluloid, is based on his own historical researches. As a chemist and tutor in polymer chemistry, he is well fitted for the job, which he does in two parts, the first being concerned entirely with celluloid. The second brings the picture right up to date, painting with the modern spectrum of the plastics from the semi-synthetics based on casein and cellulose to the "thermoplastic giants", like PVC and polythene, and the crosslinked polymers.

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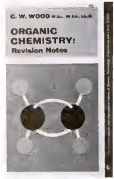

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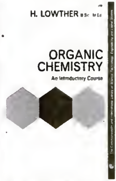

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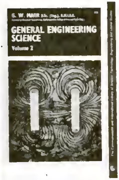

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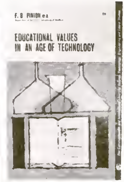

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The work is intended to act as a general guide to techniques and development in scientific laboratory work. It provides information for those workers already engaged in any given field, and also offers those students at the outset of a career in laboratory work a broad survey of the opportunities open to them, enabling them to choose their directions of work in full knowledge of the possibilities. The book, a one-volume work, has been written by 47 contributors, each a specialist in his own field.

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by A. Jackson, A.Met. (Sheffield), F.I.M., C.G.I.A.

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Ready March

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consulting editor Sidney Jefferson, B.Sc., A.C.G.I.

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RADIOISOTOPE LABORATORY TECHNIQUES

by R. A. Faires and B. H. Parks

A reprint of this practical manual describing the methods and techniques which have been developed for using radioisotopes in all kinds of laboratory work. The book is based on the author's practical experience. Mr. Faires is head of the Isotope School at the Wantage Radiation Laboratories. His colleague, Mr. Parks, specialises in instrumentation for the detection and measurement of radiation. **256 pages, 2nd Edition, 2nd Impression, Illustrated. 30s.**

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NEWNES

they were made, their methods of manufacture, the sources of their supply and the scope and limitations of technology available at the time.

Mr Hodges' book describes, primarily for archaeologists, but equally for anybody else with an interest in primitive techniques and craftsmanship, the materials, mineral, vegetable and animal, available to early industry and how they were obtained, prepared and worked up into finished articles. Pottery, glass, metals, stone, wood, fibres, leather, bone and other animal materials, colours, adhesives, fuels, salts and resins are, in turn, succinctly and accurately dealt with in the fifteen chapters of Part I.

Part II is concerned with methods for their examination, as found: to identify and characterise them, study their fine structure, interpret the methods used in their manufacture and evaluate their existing state of preservation. There are eleven pages of index, mostly with single-word entries, and nine of critical bibliography.

Every chapter leaves the reader with the feeling that all essentials have been at least touched on and an indication given of where further pertinent details may be sought. The book contains information about ancient materials far beyond that which most archaeologists possess and would be a valuable addition to the shelves of any. It disposes of many ancient errors, without introducing new ones. Those detected are few and unimportant. With the inclusion of so many uncommon technical terms, this is not the least of the book's triumphs. Design and production are irreproachable.

I. W. CORNWALL.

Other books received

Survey of Progress in Chemistry. Edited by Arthur F. Scott.
Academic Press, 64s.
Sleep and Wakefulness. By Nathaniel Kleitman.
The University of Chicago Press, 90s.
A Dozen Doctors. Edited by Dwight J. Ingle.
The University of Chicago Press, 41s.
The Electron. By Robert Andrews Millikan.
The University of Chicago Press, 45s.
Stratigraphy and Sedimentation. By W. C. Krumbein & L. L. Sloss.
W. H. Freeman, 68s.
X-Ray Diffraction. By A. Guinier.
W. H. Freeman, 78s.
Foundations of Linear Algebra. By A. I. Mal'cev.
W. H. Freeman, 54s.
Rounding Errors in Algebraic Processes. By J. H. Wilkinson.
HMSO, 21s.
An Introduction to Tropical Grassland Husbandry. By R. J. McIlroy.
Oxford University Press, 18s.
The Structure and Life of Bryophytes. By E. V. Watson.
Hutchinson University Library, 15s.
Intra-Ocular Lenses and Implants. By Peter Choyce.
H. K. Lewis, 90s.
Molecular Biology of Bacterial Viruses. By Gunther S. Stent.
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Contributions by:
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- P. JACQUINOT and R. ROIZEN-DOSSIER, Apodisation
- H. GAMO, Matrix treatment of partial coherence

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Editors: E. KARLSSON, E. MATTHIAS, K. SIEGBAHN, Institute of Physics, University of Uppsala, Sweden
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Proceedings of the Symposium on this subject, held at ZEIST, The Netherlands, 1962
Editors: A. NOORDERGRAAF, N. JAGER, N. WESTERHOF, Department of Medical Physics, Physics Laboratory, University of Utrecht

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CONTRIBUTORS

David Fishlock (*Can cross-Channel hovercraft pay?*) is Technology Editor of *New Scientist*. (*pages 590-591*)

John Hillaby (*Pesticides and health*) is Biological Consultant of *New Scientist*. (*page 592*)

Bertram Vivian Bowden (*The migrant scientist*) has been Principal of the Manchester College of Science and Technology and Dean of the Faculty of Technology, University of Manchester since 1953. He is also Chairman of the Electronics Research Council, Ministry of Aviation. After graduating from the University of Cambridge he worked with Lord Rutherford and later did radar research in Britain and America. He was recently created a life peer on the recommendation of the Leader of the Opposition. (*pages 594-596*)

Stuart Pierre Eriksen (*Studying the composition of human breath*) is Associate Professor of Pharmacy in the University of Wisconsin School of Pharmacy. Besides teaching, he is also engaged in research, primarily on the thermodynamic activities of solutions both in vivo and in vitro. Aged 33 and married with three daughters, he enjoys glass-blowing, winter sports and swimming. (*pages 608-611*)

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Asa Briggs (*Unconditional surrender to facts?*) is Pro-Vice Chancellor and Dean of the School of Social Studies in the University of Sussex. He was previously Professor of History in the University of Leeds, and before that a Fellow of Worcester College, Oxford. His chief interest is the history of the 19th and 20th centuries. Professor Briggs, aged 42 with three children, lives in Lewes. He is a Fellow of the Royal Historical Society, and President of the Workers' Educational Association. (*pages 602-603*)

Vladimir Zworykin (*Communications and government*) was a Vice-President and Technical Consultant of the Radio Corporation of America (RCA) Laboratories from 1947 to 1954, when he was appointed Honorary Vice-President of the RCA. He is also Director of the Medical Electronics Center at the Rockefeller Institute, New York. Dr Zworykin is celebrated for his pioneering work in electronic television systems. Today, as National Chairman of the Professional Group in Medical Electronics of the Institute of Radio Engineers and Founder-Chairman of the International Federation of Medical Electronics, he has new interests. (*pages 603-604*)

Richard Stone (*Computer models of the economy*) is P. D. Leake Professor of Finance and Accounting in the University of Cambridge. From 1945 to 1955 he was Director of the Department of Applied Economics. At present he is directing a research group which is building a computable model of the British economy at the Department of Applied Economics. Professor Stone, who is married, is a Fellow and Past President of the Econometric Society. (*pages 604-605*)

Alexander King (*"Report of the Council for Science Policy, 1983-84"*) is Director for Scientific Affairs of the Organisation for European Co-operation and Development (OECD), a post he has held since 1961. His previous posts include those of Chief Scientist in charge of Intelligence and Overseas Divisions, DRER, Chairman of the Productivity and Applied Research Committee, OEEC, and Director of the OEEC Office of Scientific and Technical Personnel. A chemist by training, Dr King was Senior Lecturer at Imperial College, London, and was awarded the Harrison Prize of the Chemical Society in 1939. (*pages 605-606*)

James Alan Pilkington (*How to spot a satellite*) has been, since last September, a Lecturer at the London Planetarium. He previously worked at the DSIR Radio Research Station, in the Satellite Prediction Service. A graduate of the University of Edinburgh, Mr Pilkington, aged 25, is married with two small children and lives in Windsor. (*pages 612-614*)

Denzil Taylor Smith (*Wonderland revisited*) lectures in Applied Geophysics in the Department of Geology, Imperial College, London. He is in charge of a shallow-water research group, working in south-west England and the Persian Gulf on underwater mineral exploration. Mr Taylor Smith is 37 years old and married with two children. He is fervently Welsh, and fond of golf, rugby football and loafing in the sun. (*page 620*)

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OFFICIAL APPOINTMENTS

UNIVERSITY OF GHANA
Department of Chemistry

Applications are invited from suitably qualified persons for

Lectureships or Assistant Lectureships

in

(a) Organic Chemistry

(b) Physical or Inorganic Chemistry.

Experience or interest in natural product research in the case of (a) and X-ray Crystallography in the case of (b) would be an advantage.

Salary Scales:

Lecturer: £G1,050 x 50 — £G1,400 x 75 — £G1,850; £G1,900 per annum. 20% addition for non Ghanaians.

Assistant Lecturer: £G900; £G950 per annum. 20% addition for non-Ghanaians.

Entry at appropriate point. Appointment normally five years in the first instance.

Outfit allowance £G60. Car allowance £G150 per annum. Family allowance for non-Ghanaians for each child in West Africa £G50 per annum or if under age of 21 and being educated outside West Africa, £G100 per annum (Maximum five children). Part-furnished accommodation at charge not exceeding 7.0% of salary. Existing F.S.S.U. policies maintained or superannuation on similar basis.

Passages for appointee and family on appointment and normal termination. Annual vacation leave with three overseas return passages in every four years for non-Ghanaians and one every three years for Ghanaians.

Applications (eight copies) with full details of qualifications, experience, etc., and naming three referees to be sent before 31st March, 1964, to the Registrar, University of Ghana, P.O. Box 25, Legon, Accra, or to the Assistant Registrar (Overseas), University of Ghana Overseas Office, 15 Gordon Square, London, W.C.1.

UNIVERSITY OF THE WEST INDIES

Applications are invited for post of Animal Nutrition Chemist in Regional Research Centre, St. Augustine, Trinidad. Postgraduate qualifications essential, experience desirable. Duties involve organizing and carrying out research (mainly applied) with dairy cattle, sheep and swine, and a course of lectures to undergraduate students (one term per academic year). Appointment, for three years initially, in (a) Assistant Lecturer or (b) Lecturer Grades. Salary scales: (a) £1,200 × £50 — £1,350 p.a. (b) £1,450 × £60 — £1,810 × £80 — £2,290 p.a. Child allowance £150 p.a. first child, £100 p.a. second, £50 p.a. third. F.S.S.U. Housing allowance of 10% of basic salary, or if available, unfurnished accommodation let by University at 10% of basic salary. Up to five full passages on appointment, normal termination and triennial study leave. Detailed applications (6 copies) naming three referees should be sent by March 31, 1964, by persons living in the Americas and the Caribbean area to Registrar, University of the West Indies, Kingston 7, Jamaica, and by all others to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1. Further particulars may be obtained similarly.

ST. DUNSTAN'S

Psychologist, preferably immediate post doctorate, required for psychological researches and evaluation trials of an acoustic blind mobility aid

An Experimental Officer will be appointed as an assistant and laboratory facilities are available

The appointment will be for a period of three years and the salary will be commensurate with qualifications.

Applications to the Secretary, St. Dunstan's, 191 Marylebone Road, London, NW1.

AUSTRALIA
COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION
DIVISION OF PHYSICAL CHEMISTRY
FELLOWSHIP IN SURFACE CHEMISTRY

Applications are invited for a Research Fellowship in Surface Chemistry tenable in the Division of Physical Chemistry. The Division is located at Fishermen's Bend, Melbourne, and is one of the six Divisions of the C.S.I.R.O. Chemical Research Laboratories.

The Division's research programme in surface chemistry covers a range of subjects, both basic and applied. It includes work on the mechanisms of spreading from solids and liquids at liquid surfaces and the influence of surface films on mass transfer and on liquid flow. The programme of applied work is founded on the use of surface films for reducing evaporation from water storages, and includes some work in the fields of meteorology and hydrology. The training and interests of the appointee will be considered in determining his participation in the investigations.

The Fellowship will be offered initially for a period of three years, with the possibility of an indefinite appointment at the end of the term.

Applicants should have a Ph.D. degree in mathematics, physics, chemistry or other appropriate subjects or have had postgraduate research training of equivalent standard and duration supported by satisfactory evidence of research ability.

SALARY: Dependent upon qualifications and experience within the ranges: £A1,979-£A3,115 p.a.

Salary for women will be £A188 p.a. less than corresponding rates for men.

Fares paid for the appointee and his dependent family and return fares to point of origin will be paid if, by arrangement, the appointment is not extended. Consideration may also be given to the continuation of F.S.S.U. arrangements. Further particulars supplied on application to:

Mr. W. Hartley, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, to whom applications (quoting Appointment No. 586/26) should be addressed by the 4th April, 1964.

ESSEX
SOUTH-WEST ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART
Forest Road, Walthamstow, E.17

Applications are invited for the following posts from 1st September, 1964:—

1. LECTURER to teach Zoology to B.Sc./Part I and Part II (London External) students.

   Candidates should hold an Honours Degree in Zoology and should have suitable teaching, industrial and/or research experience, particularly in applied biology, would be a recommendation.

2. ASSISTANT LECTURER GRADE B in GEOLOGY. Candidates should have a good Honours Degree in Geology and have had some teaching experience. Field or research experience would be an added recommendation.

The person appointed will be required to teach B.Sc. General (first year) Geology, and conduct field work; some teaching of either Botany or Zoology up to the standard of Part 1 B.Sc. General may also be required

Salary scales:—

Lecturer—£1,670 x £45 (5) to £1,895 p.a.

Assistant Lecturer Grade B—£838 to £1,450 p.a. All salaries subject to London addition of £45 p.a. or £60 p.a.

For the Grade B post, higher scales will apply if training and graduate qualifications are in accordance with 1963 Further Education Salaries Report requirements, and increments above the scale minimum allowed for previous teaching, war/National Service and approved relevant industrial experience.

Assistance towards the cost of removal expenses will be considered.

Application forms and further particulars obtainable from the Principal, to whom detailed applications should be sent within the next 14 days.

UNIVERSITY COLLEGE OF CAPE COAST, GHANA
Faculty of Science

Applications are invited from scientists for the post of

Professor and Head of the Faculty of Science

The successful candidate will be responsible for organising lectures and research.

Applicants must have had considerable experience in research and lecturing in a University in either Physics, Chemistry, Zoology or Botany. In addition, they should have had administrative experience. Experience in Asia or Africa is desirable but not essential.

Salary.

Ghanaian: £G2,600 p.a.

Non-Ghanaian: £G3,000 p.a.

Appointment normally five years in the first instance. Outfit allowance £G60 (where applicable). Car maintenance allowance £G150 p.a. Family allowance for non-Ghanaians £G50 p.a. for each child in West Africa or, if under 21 years of age and being educated outside West Africa, £G100 p.a. (maximum five children). Accommodation with basic furniture. Rent not exceeding 7.5 per cent of salary. F.S.S.U. Policies maintained if already held or superannuation on similar basis.

Passages for appointee and family on appointment and normal termination payable. Annual leave with three return passages in every four years for non-Ghanaians and one in every three years for Ghanaians.

Applications (six copies) giving details of qualifications, etc., and naming three referees should reach the Assistant Registrar (Overseas), University College of Cape Coast, 15 Gordon Square, London, W.C.1, not later than Saturday, 14th March, 1964.

THE UNIVERSITY OF LIVERPOOL

Applications are invited for the following posts:—
Tenable from 1 October 1964.

(a) Lecturer in the **Department of Psychology.** Candidates should have special interest in either (a) comparative and physiological psychology or (b) cybernetics and experimental psychology. The initial salary will be within the range £1,250-£1,370 per annum, according to academic qualifications and experience. (Ref.84A)

(b) Demonstrator in the **Department of Psychology.** The salary will be £875 per annum. The duties of a demonstrator consist in taking charge of elementary practical classes and tutorial groups. Demonstrators are also expected to engage in research and may register for higher degrees, including Ph.D. The tenure of the post is limited to three years. (Ref.84B)

(c) Assistant Lecturer in the **Department of Genetics.** The salary will be within the range £1,000-£1,150 per annum, according to age, academic qualifications and experience. (Ref.-84C)

(d) Senior Lecturer, Lecturer and Assistant Lecturer in the **Department of Civil Engineering.** Applicants should have interests in the fields of soil mechanics, water supply and sewage disposal, structures or traffic engineering. The range of salaries for a Senior Lecturer is at present £2,200 to £2,700 per annum, for a Lecturer £1,250 to £2,150 per annum, for an Assistant Lecturer £1,000 to £1,150 per annum. The initial salaries will be according to age, academic qualifications and experience. (Ref.84D)

(e) Senior Technical Officer in the **Department of Civil Engineering.** The Senior Technical Officer should be interested in the use and development of testing machines and techniques, but applicants need not be civil engineers. The salary will be within the range £1,150-£1,850 per annum, according to age, qualifications and experience. (Ref.84E)

(f) Lecturer and Assistant Lecturer in the **Department of Mechanical Engineering.** Applicants should have interests in the fields of applied mechanics, engineering design or high temperature gas dynamics. The range of salaries for a Lecturer is £1,250 to £2,150 per annum, for an Assistant Lecturer £1,000 to £1,150 per annum. The initial salaries will be according to age, academic qualifications and experience. (Ref.84F).

(g) Lecturer and Assistant Lecturer in the **Department of Electrical Engineering.** Candidates who are honours graduates in Electrical Engineering or Physics with research experience in studies of gaseous electrical discharges, solid state electronics, control systems and machine analysis are specially encouraged to apply, but candidates with other research interests are not excluded from consideration. The salary will be within the range £1,250-£2,150 per annum for a Lecturer and within the range £1,000-£1,150 per annum for an Assistant Lecturer. (Ref.84G)

Tenable from 1 October, 1964, or such other date as may be arranged.

(h) Lecturer or Assistant Lecturer at the **Tidal Institute and Observatory.** Candidates should be graduates in Mathematics or Physics and will be required to engage in the numerical and theoretical analysis of problems concerning tides and storm surges. The initial salary will be within the range £1,000-£1,430 per annum, according to age, qualifications and experience. (Ref.84H)

Applications, stating age, qualifications and experience, quoting appropriate reference number, together with the names of three referees, should be received not later than 17 March, 1964, by the Registrar, from whom further particulars may be obtained.

THE UNIVERSITY OF MANCHESTER

Applications are invited for the post of LECTURER or ASSISTANT LECTURER in the Department of Physics in the Faculty of Science. Preference will be given to applicants with interests in low temperature solid state physics. Duties to commence as soon as possible. Salary scales: Lecturer, £1,250 to £2,150 per annum; Assistant Lecturer, £1,000 to £1,150 per annum; initial salary and status according to qualifications and experience. Membership of the F.S.S.U. and Children's Allowance Scheme. Forms of application and further particulars including details of research facilities may be obtained from the Registrar, the University, Manchester 13, to whom applications should be sent not later than March 31st, 1964. Applications by airmail letter in the first instance will be received from overseas candidates, who should state the names and addresses of at least three persons to whom reference can be made.

UNIVERSITY OF ADELAIDE
AT BEDFORD PARK
Further Professorial Appointments

In the School of Language and Literature:

PROFESSORS OF ROMANCE LANGUAGES
(Two appointments)

It is envisaged that one chair will be filled by a candidate whose main interests lie in the field of French language and literature and that the other will be filled by a candidate qualified in either Italian or Spanish.

In the School of Social Sciences:

PROFESSOR OF GEOGRAPHY

Courses within this School will be closely interrelated; consequently it is intended to concentrate on the human and social aspects of geography.

PROFESSOR OF SOCIAL AND POLITICAL STUDIES

Applications will be welcomed from scholars with interests in political science, political philosophy, public administration, social administration or sociology.

In the School of Physical Sciences:

PROFESSOR OF MATHEMATICS

Applications will be welcomed from candidates in the fields of either pure or applied mathematics.

PROFESSOR OF CHEMISTRY

The first Professor of Chemistry is an organic chemist. Applications will be welcomed from candidates in the fields of physical or inorganic chemistry.

In the School of Biological Sciences:

PROFESSORS OF BIOLOGY
(Two appointments)

The main interests of the first Professor of Biology are in zoology and genetics. Applications for the two new chairs will be welcomed from biologists interested in biochemistry, cellular biology (in its broadest sense), morphogenesis, biophysics or molecular biology.

The salary for each Chair is £A4,600 a year with superannuation on the F.S.S.U. pattern.

In 1966 the University of Adelaide will extend its work to a second site at Bedford Park, about seven miles south of the city of Adelaide. Academic work at the new Bedford Park site will be organised initially in the above four Schools and will be under the control of the Bedford Park academic staff. An individual structure of courses will be introduced and new developments encouraged. Full degree work in the four Schools will begin with first year courses in 1966 and second and third year courses will be added in succeeding years. Facilities for honours and postgraduate work and research will be available from the outset.

The successful candidates will be required to take up duty during 1965. Professors of English, History, Economics, Chemistry, Physics and Biology and the Librarian have already taken up duty. The acquisition of books for the Bedford Park Library, which will open with 60,000 volumes, is now well advanced. Plans are also well advanced for new buildings to house the four academic schools, the library and the students' union.

Enrolments are expected to be about 500 in 1966 rising to about 2,000 in 1970.

A statement giving fuller information about the development of Bedford Park and setting out conditions of appointment may be obtained from the Registrar of the University or from the Secretary, Association of Commonwealth Universities (Branch Office), Marlborough House, Pall Mall, London, S.W.1.

Applications, in duplicate, should reach the Registrar of the University at North Terrace, Adelaide, South Australia, not later than **31st May, 1964.**

UNIVERSITY OF SINGAPORE

Applications are invited for (a) Lectureships or (b) Assistant Lectureships in:

(i) Chemistry
(ii) Mathematics
(iii) Pharmacognosy

Salary scales: (a) £1,148 x £49 — £1,442/£1,540 × £56 — £1,820 p.a. (b) £1,001 × £49 — £1,099 p.a. Entry point according to qualifications and experience. Allowances: expatriation in range £280 — £300 p.a., cost of living (temporary) in range £210 — £560 p.a. Passages for appointee, wife and children not exceeding 12 years. Partly furnished house/flat at reasonable rent. Provident Fund Scheme. Detailed applications (8 copies) naming 3 referees by March 31, 1964, to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1., from whom further particulars may be obtained.

BRIGHTON EDUCATION COMMITTEE
Westlain Mixed Grammar School
(School opened in 1957 No. on roll 650)

Required September, 1964:—

Assistant Master/Mistress to take Physics throughout the School

Share of sixth form work available.

Scale II allowance for suitably qualified applicant but candidates seeking first appointment would also be considered

Form of application and further details from undersigned for return to Headmaster as soon as possible

W. G. STONE
Director of Education.

54 Old Steine,
BRIGHTON.

AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF ENTOMOLOGY

BIOCHEMIST INSECTICIDE INVESTIGATIONS

Applications are invited for appointment as Research Officer (Insecticide Biochemist) with the Organization's Division of Entomology located at Canberra, A.C.T.

The Division is the main centre in Australia for research on insects and it is actively engaged on many problems of economic importance; the professional staff numbers about 60. The Division's research programme embraces all aspects of entomological research, with particular emphasis at the present time in the fields of population dynamics and ecology of pest species, physiology and biochemistry of insects, insect taxonomy, and biological control. The Division is well equipped for biochemical investigations and there is a wide range of facilities including radioactive tracer and scanning equipment; nuclear magnetic resonance spectroscopy; electron microscopy; paper chromatography and electrophoresis equipment; centrifuges, spectrophotometers; and a wide range of constant temperature rooms; including cold rooms.

The appointee will undertake research on the biochemistry of the action of insecticides, selective toxicity, and detoxification mechanisms of insects. Initially the work will be concerned with comparisons between insecticide-resistant and susceptible strains of the housefly, but later the appointee may be required to work with other species of insects and to participate in other biochemical projects of the Division's research programme.

Applicants should possess a University degree in Science, with biochemistry as a major subject, and a Ph.D. in Entomology or Zoology (or have had postgraduate research experience of an equivalent standard and duration supported by satisfactory evidence of research ability). Some experience in enzymology would be an advantage.

SALARY: Dependent upon qualifications and experience within the range — £A1,794-2,631 p.a.

Salary for women will be £A166 p.a. less than corresponding rates for men.

Promotion within C.S.I.R.O. is by merit and may go beyond the upper limit of the scale within which the original appointment is made. By mutual arrangement, the appointment may be either for an indefinite period or for a fixed term of three years.

Fares paid for the appointee and his dependent family and return fares to point of origin will be paid for an appointee who, by arrangement, accepts appointment for a fixed term. Further particulars supplied on application to.—
Mr. W. Hartley, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2. to whom applications (quoting Appointment No. 180/272) should be addressed by the **4th April, 1964.**

ETHIOPIA

Haile Selassie First University, Addis Ababa

Faculty of Science

Applications are invited from suitable qualified persons for the following posts:

Department of Physics:
- One Associate Professor
- Two Assistant Professors

Department of Mathematics:
- One Associate Professor
- Two Assistant Professors

Department of Chemistry:
- One Associate Professor (Physical Chemistry)

Department of Biology:
1. Assistant or Associate Professor of Zoology, with emphasis on Zoolophysiology or Embryology and Comparative Anatomy.
2. Assistant Professor with special responsibility for introductory courses. (Zoology and Botany.)

Salary Scales:
Associate Professor Eth.$ 15,000—Eth.$ 18,000 p.a.
Assistant Professor Eth.$ 12,000—Eth.$ 15,000 p.a.

The Ethiopian dollar is equivalent to U.S. $0.40 or 2/10d. The salaries are net, and in addition, a housing allowance is provided.

Contracts are for two or three years.

Passages and an allowance for moving expenses are paid on appointment and on normal termination.

For further details and application forms apply to.

The Dean of Science,
University College,
Haile Selassie First University,
P.O. Box 399,
Addis Ababa

UNIVERSITY COLLEGE OF SWANSEA

Chair of Physical Metallurgy

Applications are invited for the CHAIR OF PHYSICAL METALLURGY in the Department of Metallurgy, which will become vacant on September 30, 1964.

Particulars may be obtained from the Registrar, University College of Swansea, Singleton Park, Swansea, to whom applications must be sent by **Wednesday, March 25, 1964.**

SWEDEN

THE ROYAL SWEDISH BOARD OF EDUCATION

Lecturers in Mathematics, Physics & Electronics

The Royal Swedish Board of Education requires:
6 British Lecturers (2 to teach Mathematics,
2 to teach Physics,
2 to teach Electronics)
for the Academic year 1964/65

These are new and experimental posts. The Board, in co-operation with the Swedish Universities, is establishing a new Degree course in these subjects (the equivalent of a B.Sc.) for Swedish University students who will, it is hoped, eventually become secondary school teachers of Mathematics, Physics and Electronics. The posts are to be filled by British Graduates who are at present qualified to teach in British UNIVERSITIES, TECHNICAL COLLEGES and COLLEGES OF ADVANCED TECHNOLOGY.

Salary: The **basic** salary will be £2,500 a year.

Accommodation: Modern Swedish 3-roomed flats plus kitchen available.

Fares over and back paid.

Dates: Contracts initially will be for ONE year (12 months). The Lecturers will not be required in Sweden before August 15, 1964.

FURTHER INFORMATION AND APPLICATION FORMS can be obtained from:

ANTHONY ABRAHAMS, M.A.,
1 Garden Court,
Temple,
London, E.C.4.

UNIVERSITY OF LONDON

Goldsmiths' College

Training Department, S.E.14

HEAD of Chemistry Department. Applications are invited for this important post which falls vacant on 1st September, 1964. New laboratories. Work to at least B.Sc. General Standard. Good degree, experience and research essential. Salary £2,045 x £70 — £2,325 per annum plus London Allowance.

This post should soon qualify for a substantial responsibility allowance in addition. Further particulars from the Registrar to whom applications (5 copies) should be sent as soon as possible.

BRIGHTON EDUCATION COMMITTEE

Brighton College of Technology

Required for 1st September, 1964

Department of Computing, Cybernetics and Management

Senior Lecturer or Lecturers, according to qualifications and experience in:—

1. DATA PROCESSING and OPERATIONAL RESEARCH TECHNIQUES.
2. NUMERICAL ANALYSIS and COMPILER WRITING.
3. ECONOMICS (with special reference to Marketing)
4. SOCIOLOGY (with special reference to Statistical Techniques)
5. BUSINESS LAW.

Lecturers or Assistant Lecturers Grade B in:
Department of Applied Physics

6. & 7. APPLIED PHYSICS.

Department of Chemistry

8. APPLIED CHEMISTRY
9. ORGANIC CHEMISTRY

Applicants must possess an appropriate good degree, diploma in technology, or professional qualification, together with suitable industrial and/or research experience. Teaching experience desirable. Good facilities for research at the College, which provides courses wholly in the field of advanced technology and management.

Salary Scales:
Senior Lecturer: £1,895 x 55 — £2,115 p.a.
Lecturer: £1,670 x 45 — £1,895 p.a.
Assistant Lecturer Grade B: £930-£1,760 p.a.

Increments may be granted within each scale for approved experience.

Full particulars and application forms may be obtained from the Registrar, Brighton College of Technology, Moulsecoomb, Brighton 7, to whom completed forms should be returned by 23rd March, 1964.

W. G. STONE,
Director of Education.

UNIVERSITY OF GHANA

Department of Geography

Applications are invited for the post of

Lecturer or Assistant Lecturer

Candidates should be honours graduates in geography, who are qualified to teach Economic Geography or Political Geography and the Regional Geography of Africa.

Salary Scales:
Lecturer: £G1,050 x 50 — £G1,400 x 75 — £G1,850; £G1,900 per annum. 20% addition for non Ghanaians.
Assistant Lecturer: £G900; £G950 per annum. 20% addition for non-Ghanaians.

Entry at appropriate point. Appointment normally five years in the first instance.

Outfit allowance £G80. Car allowance £G150 per annum. Family allowance for non-Ghanaians for each child in West Africa. £G50 per annum or, if under age 21 and being educated outside West Africa, £G100 per annum (maximum five children). Part-furnished accommodation at charge not exceeding 7.5% of salary. Existing F.S.S.U. policies maintained or superannuation on similar basis.

Passages for appointee and family on appointment and normal termination. Annual vacation leave with three overseas return passages in every four years for non-Ghanaians and one every three years for Ghanaians.

Applications (eight copies) with full details of qualifications, experience, etc., and naming three referees to be sent before 31st March, 1964 to the Registrar, University of Ghana, P.O. Box 25, Legon, Accra, or to the Assistant Registrar (Overseas), University of Ghana Overseas Office, 15 Gordon Square, London, W.C.1.

UNIVERSITY OF BIRMINGHAM

Faculty of Science

Applications are invited for the post of LECTURER or ASSISTANT LECTURER in STATISTICS in the Department of Pure Mathematics.

Appointments will be made in the scale £1,250 x £60 — £1,670 x £80: £1,830 x £80 — £2,150 p.a. in the Lecturer grade and in the scale £1,000 x £50 — £1,150 p.a. in the Assistant Lecturer grade and will carry F.S.S.U. and Family Allowance benefits. The initial stipend will be fixed according to qualifications and experience.

Applications (three copies) naming three referees should be sent by 4th April, 1964, to the Assistant Registrar (Science), the University, Birmingham 15, from whom further particulars can be obtained.

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

KUMASI, GHANA

Faculty of Engineering

A. **Professors and Heads of Departments**
   (a) Mechanical Engineering
   (b) Electrical Engineering
   Qualifications

Candidates should be graduate engineers with extensive relevant experience in teaching and/or industry. Preference will be given to holders of a higher degree and/or similar appointments. Successful candidates will be expected to assume, under the direction of the Dean of the Faculty, full responsibility for the work of their departments. There are at present 1 Reader, 3 Senior Lecturers and 7/18 Lecturers in the department and numbers to be doubled in the next 4/5 years. They will also be expected to promote, conduct and supervise research projects by both staff and post-graduate students.

B. **Reader or Senior Lecturer—**
   Land Surveying
   Qualifications

Candidates should be graduates and professional Land Surveyors with extensive teaching experience in Geodesy, Topographical Surveying and Computations up to and including degree and/or full professional qualification standards. Preference will be given to holders of a higher degree and/or similar appointments.

Candidates will be expected to assume charge of the teaching and responsibility for development of the course—now in its second year—up to degree standard.

C. **Senior Lecturer—**
   (1) Telecommunication
   (2) Electrical Theory and Measurement
   (3) Electrical Power Generation and Supply
   Qualifications

Candidates to possess a degree in Engineering with not less than 5 years teaching experience up to and including degree level. Preference will be given to holders of higher degree or similar relevant posts. Research and/or industrial experience will be an advantage.

The successful candidate will, in addition to his teaching duties, take charge of the teaching of his subject at all levels including degree, develop· existing laboratory facilities conduct and initiate research activities.

D. **Lecturers**
   (a) Mechanics of Machines
   (b) Engineering Drawing and Engineering Design
   (c) Stress Analysis and Metallurgy
   (d) Thermodynamics
   (c) Electrical Engineering (Light Current)
   Qualifications

Candidates should possess an honours degree in the relevant subject, with teaching and/or industrial experience. Preference will be given to holders of a higher degree and who can offer an additional relevant subject, e.g., Design Machine Elements with Engineering Drawing.

Successful candidates well be expected to teach up to degree level, conduct research and to help generally.

E. **Assistant Lecturers**
   (a) Civil Engineering
   (b) Mechanical Enginrering
   (c) Electrical (Light and Heavy) Engineering
   Qualifications

Candidates to possess a degree in Engineering. Preference will be given to holders of an honours degree.

Successful candidates will be expected to undertake some teaching duties but mainly expected to help in the conduct of tutorial and laboratory classes.

F.S.S.U. Scale

Professor: £2,600 per annum
Reader: £2,272. 14/- per annum
Senior Lecturer: £2,520 x £108—£3,180 per annum
Lecturer: £1,512 x 73 — £2,818 x £108 — £2,664; £2,736 per annum
Assistant Lecturer: £1,296 x 72 — £1,368 per annum

Contract scale 18% higher can be arranged.

Point of entry depends on previous relevant experience. For short term appointments salary by negotiation.

Appointments are normally for five years in the first instance and may be renewed; one term's notice of resignation or termination of appointment is required on either side. Outfit allowance, £60 (where applicable). Car maintenance allowance £150 per annum. Children's allowance at the rate of £50 per annum per each child resident in Ghana and £100 per annum per each child in full time education oversees up to a maximum of 31 years of age (maximum five children). Accommodation with basic furniture provided. Rent not exceeding £150 per annum. F.S.S.U. policies maintained if already held or superannuation on similar basis.

Free passages for appointee, his wife and up to five children are provided on appointment and normal termination. Annual leave with three free return passages in every four years.

Application forms and further information may be obtained from the Assistant Registrar, Kwame Nkrumah University of Science and Techonlogy, 18 Gordon Square, London, W.C.1. Completed application forms should reach him not later than 31st March, 1964. Interviews to be held early April and appointments confirmed by end of April.

AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF PLANT INDUSTRY

PLANT ANATOMIST

Applications are invited for appointment as Research Officer (Plant Anatomist) with the Organization's Division of Plant Industry at its headquarters laboratories at Canberra, A.C.T.

The appointee will initially be required to collaborate in research on the floral histogenesis of the monocotyledons. There will be opportunity to participate in other research programmes of the Division and to initiate new research.

Applicants should possess a Ph.D. degree in Botany or have had postgraduate research experience in plant morphology or anatomy of equivalent standard and duration supported by satisfactory evidence of research ability.

SALARY: Depending on qualifications and experience within the ranges:
£A1,794-£A2,831 p.a. (but not less than £A2,099 p.a.) or £A3,755-£A3,115 p.a.

Salary for women will be £A188 p.a. less than corresponding rates for men.

Promotion within C.S.I.R.O. is by merit and may go beyond the upper limit of the scale within which the original appointment is made.

By mutual arrangement, the appointment may be for an indefinite period or for a fixed term of three years. In the case of a fixed term appointment, consideration may be given to the continuation of F.S.S.U.

Fares paid for the appointee and his dependent family and return fares to point of origin will be paid for an appointee who, by arrangement, accepts appointment for a fixed term.
Further particulars supplied on application to
Mr. W. Hartley, Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, to whom applications (quoting Appointment No. 130/556) should be addressed by the 4th April, 1964.

UNIVERSITY COLLEGE OF CAPE COAST, GHANA

Faculty of Science

Applications are invited from Graduates with good Honours Degrees for **Assistant Lectureships, Lectureships and Senior Lectureships** in BOTANY, CHEMISTRY, PHYSICS, ZOOLOGY and MATHEMATICS:

Botany—Applicants may be specialists in Physiology.

Chemistry—Specialists in any branch.

Physics—Applicants may be experimental Physicists.

Mathematics—Pure Mathematicians or Statisticians.

Zoology—Specialists in vertebrate Zoology.

For Lectureships, relevant teaching experience would be an advantage; for Senior Lectureships, considerable administrative or research experience is essential.

Salary Scales:
Senior Lecturer—£G1750 x £G75-£G2200 p.a.
Lecturer—£G1050 x £G50-£G1400 x £G75-£G1850;
Assistant Lecturer—£G900; £G850; £G1850 x £G50-£G1400 x £G75-£G1850; £G1900.
20% addition for non-Ghanaians.

Appointment normally five years in the first instance. Outfit allowance: £G60 (where applicable). Car maintenance allowance: £G150 p.a. Family allowance for non-Ghanaians: £G50 p.a. for each child in West Africa or, if under 31 years of age and being educated outside West Africa, £G160 p.a. (maximum five children). Part-furnished accommodation. Rent not exceeding 7.5 per cent of salary. F.S.S.U. Policies maintained if already held or superannuation on similar basis.

Passages for appointees and families on appointment and normal termination. Annual leave with three return passages in every four years for non-Ghanaians and one in every three years for Ghanaians.

Application forms, obtainable from the Assistant Registrar (Overseas) University College of Cape Coast, 15 Gordon Square, London, WC1 should be returnable to reach him not later than Saturday, 14th March, 1964.

L.O/EDA/Sc.4
February, 1964.

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

(Faculty of Technology in the University of Manchester)

Applications are invited from Cell Biologists for a LECTURESHIP in the Department of Biochemistry, with corresponding title and status in the University of Manchester. The post has been established in connexion with a new course in Cell Biology for Honours students of Biochemistry. Applicants should have a degree in Botany, Zoology or Physiology and preferably have carried out research in one of these fields. An interest in biochemical or biophysical problems would be an advantage.

Salary scale: £1,250 x £60 — £1,870 x £80 —£2,150.

Superannuation under F.S.S.U. — Family allowances.

Application forms and further particulars may be obtained from The Registrar of the College, Sackville Street, Manchester 1, to whom completed applications must be returned by Saturday, 28th March, 1964.

WHITE FISH AUTHORITY

Seed Oyster Unit

The White Fish Authority is setting up a unit at Conway, North Wales, at which the problems of rearing oysters from spat to a size suitable for laying in an open natural environment will be investigated and a technique for mass production evolved.

Applications are invited from a man with a degree in natural sciences or, alternatively, with experience in animal husbandry and the development of techniques of breeding and rearing of animals in controlled conditions, to take charge of the unit. He should be interested in evolving techniques suitable for commercial adoption and be capable of costing the operation. He will not be required to undertake fundamental research.

Appointment will be for a period of three years in the first instance and salary will be in the range of £1,340-£2,180 per annum.

Application forms and further particulars are available from the Secretary/Solicitor, White Fish Authority, Lincoln's Inn Chambers, 2/3 Cursitor Street, London, E.C.4. Completed forms should be returned by 16th March, 1964.

THE UNIVERSITY OF SUSSEX

Applications are invited for posts of

ASSISTANT LECTURER or LECTURER (or, in special cases, SENIOR LECTURER) in MATHEMATICS

from October 1964 or from October 1965. Appointments may be made in any branch of the subject.

The salary scales are:
Senior Lecturer: £1,700 x £100 — £2,500 per annum;
Lecturer: £1,250 x £60 — £1,678 x £80 — £2,150 per annum (efficiency bar at £1,750 per annum);
Assistant Lecturer: £1,008 x £50 — £1,150 per annum; plus family allowance and F.S.S.U. benefits.

Further particulars may be obtained from the Registrar, University of Sussex, Stanmer House, Stanmer, Brighton, to whom applications should be sent by 11th April, 1964, or as soon as possible thereafter.

UNIVERSITY OF BELFAST

Lectureship in Genetics

The Senate of The Queen's University of Belfast invites applications for a Lectureship in Genetics from October 1, 1964. Candidates are required to have special qualifications and interests in either Microbial Genetics or Population Genetics. The post is the first of a number which it is hoped to establish. Salary range £1,250 to £3,150 plus contributory pension rights under the F.S.S.U. Initial placing on the salary scale will depend on qualifications and experience. Applications should be received by March 31, 1964. Further particulars may be obtained from G. R. Cowie, M.A., LL.B., J.P., Secretary.

THE UNIVERSITY OF SUSSEX
Second Chair of Chemistry
Preliminary Announcement

It is intended to make an appointment, for October 1st, 1965, or earlier, to a second Chair in Chemistry. Enquiries, which will be treated in confidence, will be welcomed, from qualified persons who might wish to be considered for this post. They should be addressed to the Registrar, University of Sussex, Stanmer House, Stanmer, Brighton, Sussex, and should be marked Confidential.

APPOINTMENTS AND SITUATIONS VACANT

THE UNIVERSITY OF MANCHESTER

Applications are invited for the post of Experimental Officer in the Department of Preventive Dentistry. Applicants should possess a degree or equivalent qualification in Zoology or Biochemistry. The person appointed will work in a team on nutritional and other experiments with animals and will have the opportunity to apply highly specialised techniques using optical microscopes. Salary range: £880 x £40 to £1,200 per annum. The initial salary will be according to qualifications and experience Contributory superannuation scheme. Applications should be sent as soon as possible to the Registrar, the University, Manchester 13, from whom further particulars may be obtained.

THE UNITED SHEFFIELD HOSPITALS

Applications are invited for the post of

Scientific Officer
(Basic Grade)

from holders of a science degree of a British University (or qualifications approved by the Ministry of Health) having appropriate experience as laid down by Whitley Councils. Salary in accordance with P.T.A. 102. The successful candidate will work in the blood banks of the Department of Haematology under the direction of the Consultant Haematologist. Visit to Department can be arranged. Applications naming three referees to be sent to:—

The Chief Administrative Officer,
UNITED SHEFFIELD HOSPITALS,
West Street Sheffield 1

by 14th March.

'RESEARCH FELLOWSHIPS'

at the ATOMIC ENERGY ESTABLISHMENT
WINFRITH, DORSET

* * *

Applications are invited for Fellowships valued at between £930 and £1,910 per annum (with occasional appointments above this range) and tenable for one to three years for research in:

COMPUTING

FLUID DYNAMICS AND HEAT TRANSFER

NUCLEONIC INSTRUMENTATION

REACTOR CONTROL AND KINETICS

REACTOR PHYSICS

Closing date for applications 31st March, 1964, for election in June, 1964. Please write for further information to the Secretary, Winfrith Fellowships Board, A.E.E., Winfrith, Dorchester, Dorset.

APPLICATIONS are invited for the post of assistant to the manager of CARWORTH LABORATORIES, INC., USA. Salary will be $6,000 per annum, and academic attainment should be at least advanced level GCE in Botany and Zoology and intermediate or advanced examinations of the Institute of Medical Laboratory Technology, Institute of Science Technology, Animal Technicians Association, or of some similar professional organization The applicant should have experience of working with laboratory animals both in the animal house and in the laboratory, such as might be gained in a bacteriology or pharmacology laboratory, and should also have had some supervisory experience.

The applicant should prefer to work within an organization which is commercially rather than academically motivated, while realizing that the two approaches cannot be mutually exclusive. This company is expanding in areas of new disciplines and the future holds promise of professional and personal advancement.

In order to avoid service in the US Armed Forces the applicant must be either married and living with his wife, or 26 years of age or over, or have served 18 months or more in the British Armed Forces All persons are required to register

Applications should be sent by airmail to Mr. C. N. Wentworth Cumming, Carworth Laboratories, Inc., Congers Road, New City, Rockland County, N.Y., USA. Interviews will be in Gt. Britain.

ROLLS ROYCE

ROLLS-ROYCE
TECHNICAL LIBRARIAN

A Technical Librarian is required by Rolls-Royce Limited to take charge of the Library serving their advanced research work in the fields of material science and aero dynamics.

Applicants must be Chartered Librarians in the age group 25-35 with experience in a special library and be familiar with U.D.C.

Candidates will preferably possess a scientific background with some reading ability in French/German and possess a degree.

The library is pleasantly located on the outskirts of Derby, and conditions of work are excellent.

Applications should be addressed to the Head of the Advanced Research Group, Rolls-Royce Limited, Old Hall, Littleover, Derby.

THE ROYAL VETERINARY COLLEGE
(UNIVERSITY OF LONDON)
Department of Medicine

Qualified Laboratory Technician required. The work will be mainly concerned with physical apparatus, used in clinical diagnosis and clinical research at the Animal Hospital at Camden Town.

Salary scale £580-£815 plus London Weighting and Qualification Allowance. There are prospects of promotion. Superannuation scheme. Application form from Assistant Secretary, The Royal Veterinary College, Royal College Street, London, N.W.1.

BIRKBECK COLLEGE
(University of London)

Computer Engineer required for the maintenance of a large valve computer in the Department of Computer Science. Experience of commissioning computers essential. A young graduate would be preferred, but candidates otherwise qualified would not be excluded: research facilities would be granted if appropriate. Initial salary in the region of £1,500 p.a. on a scale to be agreed. Further particulars should be obtained from the Secretary, Birkbeck College, Malet Street, W.C.1; enquiries should include a brief statement of qualifications and experience.

Scientific Civil Service

SCS

IMPORTANT NEWS
for those graduating in 1964
(and other SCIENTISTS)

If you have reasonable expectation of gaining 1st or 2nd Class Honours in a Science Degree, you can apply now for appointment as

SCIENTIFIC OFFICER

The SCIENTIFIC CIVIL SERVICE offers a first-rate career in work of national importance, either in CIVIL SCIENCE—to ensure the contribution of research to the national economy—or in challenging studies in the field of DEFENCE SCIENCE. Physicists, Chemists, Mathematicians and Engineers are required in many Government Departments, but Biological vacancies are usually specialised. Candidates successful at interview will be offered provisional appointment until the announcement of examination results.

Salary scale is £781-£1,309 with an extra allowance (up to £60) for duties in the London Area After 2 years' satisfactory service there is a special addition of £95. Increments to starting salary can be given for national service and post-graduate experience Permanent appointments carry a generous pension; promotion prospects are good.

Full information about the Scientific Civil Service is available in a Booklet from the address below and visits to Government Research Establishments by prospective candidates are encouraged

There are also vacancies as

SENIOR SCIENTIFIC OFFICER

for Scientists, aged at least 26 and normally under 32, who have a minimum of three years' post-graduate experience. Salary scale is £1,438-£1,772, also supplemented in the London area.

Write to Civil Service Commission, 23 Savile Row, London, W.1, stating age and qualifications and quoting S/52-53.

MINISTRY OF AVIATION
SIGNALS RESEARCH AND DEVELOPMENT ESTABLISHMENT
Christchurch, Hants

Opportunities in Research and Development of MODERN METHODS of COMMUNICATIONS Current studies embrace digital transmission of telephonic, telegraph, facsimile and data facilities; electronic automatic circuit switching; solid-state circuits and micro-miniaturisation. Relevant experience is desirable.

APPOINTMENTS: (on qualifications, ability and experience) as:

SENIOR SCIENTIFIC OFFICER

SCIENTIFIC OFFICER

EXPERIMENTAL OFFICER

F.S.S.U. benefits for S.S.O. and S.O.
Write for full particulars to the Director at above address, stating qualifications, experience, and grade in which interested. (Ref NC/2O/965.)

DEPARTMENT OF TECHNICAL CO-OPERATION
DIRECTORATE OF OVERSEAS SURVEYS
Tolworth, Surrey

DEPUTY DIRECTOR

APPLICATIONS are invited for the above post. The person appointed will take charge of the Directorate's Forestry and Land Use Section which undertakes assessment of forests and agricultural resources overseas, mainly in tropical countries within the Commonwealth, and advises on the development of those resources. Land use and related surveys are carried out at Tolworth by the use of aerial photographs and subsequent field work abroad and advice and assistance is provided to countries overseas carrying out such surveys. Visits abroad will form part of the duties
APPLICANTS must have obtained a degree or equivalent qualification in agriculture, forestry or a natural science. They must have had wide experience, including administrative, of agriculture and/or forestry in the tropics
SALARY scale £3,110 - £3,535; Starting salary may be above minimum.
Closing date 13th April 1964 (Reference S/5853/64.)

D.S.I.R.

(1) WARREN SPRING LABORATORY
Stevenage, Herts.

(a) SCIENTIFIC OFFICER/SENIOR SCIENTIFIC OFFICER for Process Economics and Design Study Group engaged in cost studies, economic surveys and statistical design of experiments, Activities mainly concerned with Chemical Engineering, Mineral Processing, Air Pollution and Ergonomics Knowledge of statistical methods and industrial experience of computer programming desirable (Reference: E/AN/035.)

(b) ASSISTANT EXPERIMENTAL OFFICER/EXPERIMENTAL OFFICER in Chemical Engineering Division. Field includes automatic and computer control of plant, gas-solid and gas liquid suspensions, technology of powders and slurries, applied catalysis and surface chemistry. Interest in plant as well as laboratory work required. (Reference: E/AN/038.)

(2) TROPICAL PRODUCTS INSTITUTE
London, W.C.1

(a) SCIENTIFIC OFFICER/SENIOR SCIENTIFIC OFFICER for work on more effective use of renewable resources of the tropics, including research on topics of chemical and biochemical nature. Experience in isolation and elucidation of structures of natural products an advantage. (Reference: YE704/8.)

(b) ASSISTANT EXPERIMENTAL OFFICER/EXPERIMENTAL OFFICER for work on isolation, purification and identification of physiologically active compounds and plants. Tone research experience in chemistry of natural products preferred. (Reference: YE707/12.)

(3) ROAD RESEARCH LABORATORY
Harmondsworth, Middx.

ASSISTANT EXPERIMENTAL OFFICER/EXPERIMENTAL OFFICER for abstracting and translating from Scandinavian and German technical literature Language qualifications essential and scientific background desirable. The Laboratory expects to move to Crowthorne, Berks., in 1966 (Reference: A78/147.)

(4) BUILDING RESEARCH STATION
Garston, Watford, Herts

(a) EXPERIMENTAL OFFICER/ASSISTANT EXPERIMENTAL OFFICER for research on use of colour in buildings. Project will involve both experimental laboratory work and large scale user studies.

QUALIFICATIONS: Degree in psychology or related subject preferred and, for Experimental Officer, some research experience necessary. (Reference: E/AF/091.)

(b) ASSISTANT EXPERIMENTAL OFFICERS for Soil Mechanics Division to assist in laboratory and outdoor experimental investigations into civil engineering problems. The work involves developing new electrical and mechanical instruments, testing soils and rocks, experimenting on structures such as foundations, earth dams, tunnels and quay walls using models in the laboratory and at full scale on construction sites. Study for higher qualifications is encouraged. (Reference: E/AF/086.)

APPLICATION FORMS from Directors at above addresses quoting appropriate reference. Closing dates 18th March for (1) - (4a), 16th March for (4b).

SCIENTIFIC OFFICER/SENIOR SCIENTIFIC OFFICER

SALARIES: S.O. £791-£1,309 (increments and special £95 award for approved post-graduate experience)
S.S.O £1,438 - £1,772 (Starting salary may be above minimum.)

Salaries are supplemented in the London area

QUALIFICATIONS:

S.O. 1st or 2nd Class Hons Degree or Dip Tech in appropriate subject. Age under 29
S.S.O. As above plus at least 3 years' post-graduate research Age 26-31

WAR DEPARTMENT

(1) DIRECTORATE OF STORES AND CLOTHING DEVELOPMENT
EXPERIMENTAL OFFICERS/
ASSISTANT EXPERIMENTAL OFFICERS

(a) One post at Farnborough, Hants, moving permanently to Colchester after 1-2 years
DUTIES. Development of SPECIAL CLOTHING for the Services, including work on design concepts, selecting materials, producing and evaluating pilot models, and preparing specifications, with emphasis on studies of user conditions The work demands originality of approach to problems. Close liaison with industry and military users required; detailed knowledge of tailoring not necessary.

QUALIFICATIONS: Degree, Dip. Tech., or H.N.C. in a science subject (preferably physics), Associateship of appropriate professional body, or equivalent; ability to apply scientific methods to investigations; some technical familiarity with a wide range of clothing materials, including coated fabrics.

(b) Two posts at Colchester, Essex
DUTIES: Laboratory work on DEVELOPMENT of TEXTILES for military purposes

QUALIFICATIONS: Degree, Dip. Tech., or H.N.C. in a science subject, or technical training to A.S.O.C. or A.T.I. standard; training and experience in textile industry, with emphasis on either dyeing and finishing or laboratory testing and general properties of fibres, yarns and fabrics

(2) ARMY OPERATIONAL RESEARCH ESTABLISHMENT
West Byfleet, Surrey

EXPERIMENTAL OFFICER/ASSISTANT EXPERIMENTAL OFFICER to take part in field and laboratory experiments concerned with the physiology of the soldier in his military environment. Field experiments include travel to overseas stations for short periods Experience in clinical biochemistry desirable F.I.M.L.T. acceptable qualification.

The appointments are unestablished but there will be opportunities to compete for established posts.
APPLICATION FORMS from War Office, C5F, London, S.W.1, stating post(s) desired.

DEPARTMENT OF AGRICULTURE AND FISHERIES FOR SCOTLAND
Marine Laboratory, Aberdeen

Four EXPERIMENTAL OFFICERS/ASSISTANT EXPERIMENTAL OFFICERS (preferably men) as follows:—
(a) Productivity Section — to assist with the biochemical analysis of marine plankton and experimental studies of plankton production Experience in biochemical techniques an asset
(b) Bottom Fauna Section—to work on the animals of the sea floor in relation to fisheries Interest in Zoology an advantage
(c) Shellfish Section — for general work in the section. An advanced training in Zoology with special knowledge of marine biology and/or experience in fisheries research required
(d) Hydrography Section — to take part in studies of the physical characteristics of the sea in areas of interest to Scottish fisheries Statistical examination of data and development and use of recording instruments involved
The posts are unestablished but offer possibilities of permanency later.
PARTICULARS from Establishment Officer, Department of Agriculture and Fisheries for Scotland, Room 168, St. Andrew's House, Edinburgh 1 Closing date 18th March, 1964

ASSISTANT EXPERIMENTAL OFFICER/EXPERIMENTAL OFFICER

SALARIES: A.E.O. £490 (age 18) - £691 (age 23) - £858 (age 26) - £1,053
E.O. £1,184 - £1,431
Salaries are supplemented in the London area
QUALIFICATIONS:
Degree, Dip. Tech., H.N.C., or equivalent in appropriate subject Under 22, minimum qualification is 2 G.C.E. 'A' levels in Scientific subjects.
A.E.O. age 18-27, E.O. 26-30.

Full details of careers in the SCIENTIFIC CIVIL SERVICE are available on request from Civil Service Commission, 23 Savile Row, London, W.1

GKN GROUP RESEARCH LABORATORY

ELECTRICAL ENGINEER

(or Physicist with Electronics)

Within the G.K.N. Group of steel-making and metal-working companies there is a unique opportunity to develop and apply novel NDT techniques and equipment. For example, current projects include:—

- **high energy fluoroscopy of hot steel blooms**
- **automatic ultra-sonic inspection of steel billets**
- **electronic methods for detection and measurement of surface defects**

To add to the existing team we are looking for an energetic young university graduate (or Dip. Tech.) with good hons. in electrical engineering (or physics) with knowledge and/or experience in electronics.

The projects, which demand a high standard of work, are carried out in close co-operation with Group companies. This job will therefore appeal to the man who has a real desire to see 'hardware' installed and running effectively in the works.

Laboratory facilities and equipment are good. Staff conditions include a 5 day week of 38½ hours, pension and life assurance schemes.

Please send details of age, education, qualifications and experience to the:—

Personnel Officer,
G.K.N. Group Research Laboratory,
Birmingham New Road, Lanesfield, Wolverhampton

A SUCCESSFUL CAREER . . .

in the LEATHER INDUSTRY

If you have initiative and are willing to accept responsibility early on in your business life, the leather trade provides an interesting career, financial rewards and the chance of rapid advancement to the top.

In tanneries, chemical, dyestuffs and other firms supplying the industry the demand for technically trained men exceeds supply. Graduates in leather science and qualified technologists hold leading positions all over the world.

You can read for a B.Sc. degree in leather science at Leeds University or for world renowned diplomas in leather technology at the National Leathersellers College in London or the College of Technology in Northampton.

The British Leather Federation provides generous maintenance grants and scholarships at all these establishments. Other scholarships are also available.

Entry qualifications are the normal university standards in at least chemistry and physics for the B.Sc. Honours course and usually G.C.E. 'O' level or equivalent for the courses at the two Colleges.

Write to the Procter Professor, Procter Department of Food and Leather Science, The University, Leeds, 2.

the Registrar, National Leathersellers College, 176 Tower Bridge Road, London, S.E.1.

the Principal, Northampton College of Technology, St. George's Avenue, Northampton.

the British Leather Federation, 9, St. Thomas Street, London, S.E.1.

ELECTRONIC Design Engineers

are required by this large sponsored research and development organisation. Applicants should have experience in one or more of the following fields:

Digital computer systems incorporating analogue peripheral equipment and digital and analogue on-line systems; Medium speed logic circuitry; Analogue and computing system design; and should have B.Sc., H.N.D. or equivalent.

Career details should be sent to the Personnel Manager

INTERNATIONAL RESEARCH & DEVELOPMENT CO. LTD.
Fossway, Newcastle-upon-Tyne 6

BICC

Have the following vacancy in their Shepherds Bush Research Laboratories:—

CHEMIST

With a bias towards physical chemistry to investigate electro-chemical aspects of corrosion and the general physical chemistry aspects of corrosion problems.

Applicants should be graduates or equivalent. Previous experience is not essential and applications from new graduates will be welcomed.

The appointment is progressive and will be to the permanent and pensionable staff of the Company after a short probationary period.

Applications should be made to the Personnel Officer, British Insulated Callender's Cables Limited, 38 Wood Lane, London, W.12.

UNIVERSITY OF THE WEST INDIES

Applications are invited for Assistant Lectureship in Physical Inorganic Chemistry in the College of Arts & Science, Trinidad, with qualifications either in Physical Inorganic or Inorganic Chemistry. Duties to be assumed as soon as possible. Salary scale £1,200 x 50 — £1,350 p.a., entry point according to age and experience. Child allowance £150 p.a. first child, £100 p.a. second, £50 p.a. third. F.S.S.U. Housing allowance of 10% of salary or, if available, unfurnished accommodation let by University at 15% of salary. Up to five full passages on appointment, on normal termination, and on triennial study leave. Detailed applications (6 copies) naming three referees, by March 31, 1964, from persons living in the Americas and the Caribbean area to Registrar, University of the West Indies, Kingston 7, Jamaica, and from all others to Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1. Further particulars may be obtained similarly.

UNIVERSITY COLLEGE OF NORTH WALES

Computing Laboratory

APPLICATIONS ARE INVITED for the post of Programmer to assist with the scientific programming activities of the Laboratory. Qualifications should preferably include a degree in Mathematics, and some experience of electronic computation is desirable.

Salary will be according to age, qualifications and experience on the scale £1,000 x £50 — £1,150. In addition there are F.S.S.U. benefits and family allowances.

Applications (two copies), giving details of age, qualifications and experience, together with the names of three referees should be sent to the Registrar by March 23rd.

THE ZOOLOGICAL SOCIETY OF LONDON

Nuffield Institute of Comparative Medicine

Technician required to take part in a new research project on the coagulation of blood.

The successful candidate will be required to work at the New End Hospital, Hampstead, in the first instance.

Initial salary, dependent upon age and experience, in accordance with M.L.T. scales for Junior or Laboratory Technicians.

Permanent post. Non-contributory Pension Scheme.

Apply in writing to Establishments Officer, Zoological Society of London, Regent's Park, London, N.W.1.

THE GLACIER METAL COMPANY LTD.

RESEARCH AND DEVELOPMENT ORGANISATION

The Company is engaged on a planned expansion of its product development resources and these posts should attract men interested in seeing new products or processes through all their phases from conception to mass production.

SENIOR METALLURGIST (B/RDO/SM)

Kind of Person Required: Not under 27 years of age. Degree, preferably Honours, in Metallurgy. At least 5 years non-ferrous metallurgy experience, preferably in industry.

Work Involved: The development of metal based bearing materials and associated manufacturing techniques.

Organisational Position: Accountable to the Manager of the Materials Research Department.

Salary: Starting salary of up to £2,100 per annum.

METALLURGIST (B/RDO/M)

Kind of Person Required: Not under 23 years of age. Degree in Metallurgy or A.I.M. Some experience of research or development work in industry and a broad knowledge of production problems.

Work Involved: (a) Investigation of metallurgical problems such as those associated with bonding bearing linings to backing materials and developing methods of manufacture.
(b) Provision of metallurgical services such as preparing microsections and metallurgical reports.

Organisational Position: Accountable to the Manager of the Research and Development Organisation Laboratories.

Salary: Starting salary of up to £1,600 per annum.

SENIOR RESEARCH INVESTIGATOR (B/RDO/SR1)

Kind of Person Required: Not under 25 years of age. A science degree, preferably in Chemistry, Applied Chemistry or Chemical Engineering and at least two years' experience in the experimental processing of plastics. Associateship of the Plastics Institute an advantage.

Work Involved: Investigating the properties of plastic materials and developing methods of manufacture of products from plastic materials.

Organisational Position: Accountable to the Manager, Materials Research Department.

Salary: Starting salary of up to £1,900 per annum.

SENIOR RESEARCH INVESTIGATOR (PHYSICAL CHEMISTRY) (B/RDO/SRI/2)

Kind of Person Required: Not under 25 years of age. Honours degree in Chemistry or Physical Chemistry. At least two years post-graduate research experience preferably in surface or polymer chemistry.

Work Involved: Investigations into the physical and chemical processes occurring on sliding surfaces.

Organisational Position: Accountable to the Manager, Materials Research Department.

Salary: Starting salary of up to £1,900 per annum.

RESEARCH INVESTIGATOR (B/RDO/R1)

Kind of Person Required: Not under 21 years of age. A degree or H.N.C. in Chemistry, Applied Chemistry or Chemical Engineering.

Work Involved: Planning and carrying out, under the direction of a Senior Research Investigator, experimental work on properties of plastic materials and in connection with the development of methods of manufacturing products from plastics.

Organisational Position: Accountable to a Senior Research Investigator in the Materials Research Department.

Salary: Starting salary of up to £1,300 per annum.

RESEARCH INVESTIGATOR (B/RDO/R1/2)

Kind of Person Required: Preferably not less than 25 years of age. Degree in General Science, Metallurgy or Physics or A.I.M.

Work Involved: Investigations into electroplating and allied techniques.

Organisational Position: Accountable to Manager, Research & Development Organisation Laboratories.

Salary: Starting salary of up to £1,600 per annum.

PLAIN
GLACIER
BEARINGS

Applications to: Personnel Manager
"B" GROUP, GLACIER METAL CO. LTD.
Alperton, Wembley, Middlesex
giving brief details about data including present salary, and quoting appropriate reference.

ST. PAUL'S GIRLS' SCHOOL, Brook Green, Hammersmith, London, W.6

PHYSICS: Post for a young HONOURS GRADUATE keen to help in the teaching of modern PHYSICS to girls (a good proportion of whom are destined for universities or equivalent) in a well-equipped, lively and expanding PHYSICS DEPARTMENT. Governors' own salary scale and State superannuation. Application should be made with testimonials to the High Mistress as soon as possible.

ASSISTANT CHEMISTS required for the Analytical Chemical Laboratory and for the quality control laboratory of an expanding chemical works in south-west Birmingham. Applicants for both positions should be in the 20-32 age group and should preferably possess H.N.C., L.R.I.C., or equivalent qualifications. The work is interesting and varied. Staff superannuation and bonus scheme are in operation. Working conditions are pleasant and there is a staff canteen. Apply in writing, giving details of qualifications and experience, to the Chief Chemist, John and E. Sturge Limited, Lifford Chemical Works, Kings Norton, Birmingham 38.

PATRA

requires a

TECHNICAL WRITER

to help communicate research to industry. Preferably a scientist or engineer with a flair for presenting technical subjects in a lively but accurate style. The job includes original writing as well as the adaptation of research workers' drafts. Ability to work to a production deadline is essential. This is a new and challenging post, calling for both tact and initiative. The man appointed will find scope to develop his distinctive contribution in an essential role.

Application forms from the **Secretary, Printing, Packaging & Allied Trades Research Association, Randalls Road, Leatherhead, Surrey.**

Scientific appointments at the Radiochemical Centre of the United Kingdom Atomic Energy Authority

Write for details to:
The Personnel Officer,
The Radiochemical Centre
Amersham, Bucks.

The Centre develops and produces radioisotopes and labelled compounds for medical, industrial and research purposes throughout the world. The work is of considerable scientific importance and interest and may include:

- ★ extraction and purification of the rarer radioisotopes and natural radioelements;
- ★ synthesis of carbon-14 and tritium compounds by chemical and biological methods;
- ★ development and preparative chemistry of cyclotron produced isotopes;
- ★ study of exchange reactions and the behaviour and stability of very high specific activity radioactive materials in solution.

To handle this and similar work, posts at several levels of responsibilities are available for pharmaceutical or biochemists and organic, inorganic and physical chemists who:

- ★ are expecting to graduate this year;
- ★ have completed a post graduate period at a University or Medical School;
- ★ have worked in a relevant field in industry or a research laboratory.

The posts are in the Scientific Officer class (for candidates with at least a good second class honours degree or equivalent) or in the Experimental Officer class (for which a pass degree or an appropriate H.N.C. is normally expected) with salaries within the following scales, depending upon age and experience:

Senior Scientific Officer £1,540-£1,900 p.a. Scientific Officer £850 - £1,405 p.a. Experimental Officer £1,250-£1,535 p.a. Assistant Experimental Officer £690 (age 21) to £920 (age 26) - £1,130 p.a.

Assistance can be given with house purchase. There is a contributory superannuation scheme.

There are also Research Fellowships tenable at Amersham, usually of three years' duration which are awarded by the Research Group Fellowship Board of the U.K.A.E.A. These will enable successful applicants to undertake research work of their own choice in relation to radioisotopes.

SCIENTIFIC EDITOR

UNILEVER LIMITED have a vacancy at their Research Laboratory at Port Sunlight for a chemist skilled in the use of English and able to advise on methods of presenting effectively the work of the Laboratory. The duties will include the editing of Research Reports and the production of Quarterly Progress Summaries; the Editor will also be expected to take an interest in methods of report production.

Although a chemical background is essential, the ability to think clearly, write concisely, and gain the co-operation of research scientists is more important than specialised technical knowledge.

Applicants should preferably be not more than 45 years of age. Salary will appropriately reflect experience.

Please apply to:

THE STAFF OFFICER (S36), UNILEVER RESEARCH LABORATORY
PORT SUNLIGHT, CHESHIRE

UNILEVER RESEARCH

JOSEPH LUCAS LIMITED

have a vacancy for

ASSISTANT DEVELOPMENT ENGINEER

to work in the Semi-conductor Device Engineering Department situated at Sutton Coldfield, Warwickshire, on various aspects of the development and manufacture of silicon devices. Applications are invited from candidates qualified in Applied Physics or Electronics to H.N.C. standard. Previous experience in electronic engineering and/or precision engineering would be advantageous. The appointment, which offers opportunity for the exercise of initiative in a rapidly expanding department, is permanent and pensionable.

Apply in writing, stating age, qualifications and experience to the:

Personnel Supervisor
JOSEPH LUCAS LIMITED
Mere Green Road, Faar Oaks, Sutton Coldfield, Warwickshire

UNIVERSITY OF GHANA

Department of Physics

Applications are invited from suitably qualified candidates for appointment as CHIEF TECHNICIAN.

Duties include supervision and training of laboratory staff, responsibility for stores, preparation of experiments for B.Sc., and other courses and assistance in research projects in the Department which cover a wide range (radioisotopes, ionosphere and geomagnetic measurements, X-ray diffraction and metal physics). There is a liquid air plant, IBM 1620 computer, photographic darkrooms and departmental workshop.

Candidates should possess Higher National Certificate or equivalent qualification and should have extensive experience of similar work.

Salary scale: The appointment is superannuable for Ghanaians on the salary scale £G1,200 × £50 — £G1,800 per annum plus personal transport allowance. In the case of non-Ghanaians the following payments will be made: 20% contract addition, family allowance, outfit allowance and a gratuity of £G150 per annum. Passages on appointment and completion of contract. Part-furnished accommodation at reasonable rental.

Applications (SIX COPIES) with full details of qualifications, experience, etc., and naming three referees, to be sent before March 31, 1964, to the Registrar, University of Ghana, P.O. Box 25, Legon, Accra, or the the Assistant Registrar (Overseas), University of Ghana, 15 Gordon Square, London, W.C.1.

BRUNEL COLLEGE

Department of Biology

ASSISTANT LECTURER in BIOCHEMISTRY required for September 1964, at this College of Advanced Technology, which is shortly to become a technological university.

Applicants should have a good honours degree or Diploma in Technology, and preferably have had relevant industrial or research experience.

Salary according to qualifications and experience rising to possible maximum of £1,730 per annum.

Further particulars and application forms available from the Academic Registrar, Brunel College, Woodlands Avenue, London, W.3. Closing date: 23rd March, 1964.

APPLICATIONS ARE INVITED from candidates below 22 years of age for an appointment as a Junior Technical Officer to work in the field of radioactivation analysis of biological material. The successful candidate will have passed the G.C.E. examination at "A" level in Chemistry and Physics. Salary at 21 £845 rising to £1,020 with good prospects of further promotion. Applications giving personal particulars together with the names of two referees should be sent to: Administrator R.B.U. Medical Research Council, Harwell, DIDCOT, Berks, marking letter and envelope GEH/2.

The European Space Technology Centre at Delft (Netherlands)

the principal laboratory of

THE EUROPEAN SPACE RESEARCH ORGANISATION

is now embarking on the implementation of the

SOUNDING ROCKET AND SPACECRAFT PROGRAMMES OF THE ORGANISATION

The first SOUNDING ROCKET launching will take place this summer and will be followed by further firings, at an increasing tempo, whilst the design study of SATELLITE SYSTEMS has already started and the development of actual satellites is also due to start this summer. The development of the facilities necessary to test these systems is under way, and the first satellite launchings should take place in the early months of 1967.

The Organisation seeks:

(a) A SENIOR ENGINEER OR PHYSICIST

able to take charge of the SOUNDING ROCKET PROGRAMME, in particular able to organise and supervise the development and assembly of rocket payloads, mostly in the Establishment but also in industry, the assessment and possibly the development of sounding rockets to be used from ranges of restricted area and the development of stabilised loads for producing the experiments; he should have experience in these or related technologies and some experience of project management;

(b) A SENIOR ENGINEER

able to take charge of the Projects Division at Delft responsible for the planning, design and development of the SATELLITES in the laboratories of the Organisation and in industry, for collaboration with the scientific groups responsible for the scientific experiments carried in these spacecraft, and for planning, design and development of all the associated facilities needed: in particular the Organisation seeks an engineer with experience in spacecraft technology or aircraft or guided weapon technology, together with a university degree or equivalent qualifications in electrical or mechanical engineering or physics. Experience of project management is essential;

(c) ENGINEERS

in the Projects Directorate already having several years' experience in space projects and able to assume responsibilities in various fields and in particular in TELEMETRY.

Candidates are invited to contact Professor AUGER at the address below and to forward a short description of Educational and professional backgrounds in relation to the posts described above referring to this advertisement.

Professor Pierre AUGER, Executive Secretary of

COPERS

36, rue La Pérouse, PARIS 16ème

UNIVERSITY OF NEWCASTLE UPON TYNE

Department of Chemical Engineering

Applications are invited from graduates, and those who will graduate this year, in Science or Engineering who wish to pursue courses of advanced study and research.

The Department is housed in a new building and excellent research facilities are available for work in both Chemical Engineering and Fuel Science. Successful candidates will become registered research students and may read for the degrees of M.Sc., of Ph.D., by research. An alternative one year course is also available leading to the degree of M.Sc. (Chemical Engineering Science) by examination. This course is concerned with an extension of the fundamental aspects of Chemical Engineering and is also designed to familiarise students with the applications of mathematical and computer techniques to Chemical Engineering problems.

All courses of study are recognised by D.S.I.R. for postgraduate studentships. Further details and forms of application may be obtained from the Registrar, 6 Kensington Terrace, Newcastle upon Tyne 2.

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

D.S.I.R. requires an ASSISTANT INFORMATION OFFICER in Exhibition Section of Information Division at Headquarters, State House, High Holborn, W.C.I.

The officer appointed will be required to assist in the investigation of scientific subjects for exposition at commercial, technical and other exhibitions, and to work in a team dealing with all aspects of display work.

A knowledge of Science is required. A degree in science, an art qualification, or some experience of display work would be of value.

SALARY: £635 (age 20) - £874 (at 25 or over), rising to £1,296.

APPLICATION FORMS from The Manager (PE.1662), Ministry of Labour, Professional and Executive Register, Atlantic House, Farringdon Street, London, E.C.4. Closing date 19th March, 1964.

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OPPORTUNITIES AT THE LATHOM GLASS RESEARCH LABORATORIES

PHYSICIST

For theoretical and experimental work on heat transfer problems in high temperature furnaces, and fluid flow investigations associated with glass making processes for which model studies have proved useful. Preferred age 25-30 with a good Honours Degree and an ability to design experiments on both small scale and pilot plant scale and to analyse the results. Some experience of high temperature processes would be useful. The scope of the work is wide and will require collaboration with other specialised groups in the Laboratories and the Works. **REF. RES/J.4**

MECHANICAL ENGINEER

For theoretical and experimental studies of Mechanical Engineering problems on fluid flow, heat transfer and the use of engineering materials at high temperature. Preferred age 25-30 with a good Honours Degree: experience in the field of aerodynamics would be useful. **REF. RES/J.5**

CHEMICAL ENGINEERS

For experimental work on prototype process plant operating at high temperatures. Preferred age 25-30 with a good Honours Degree. Experience of Physical and Chemical problems involving fluid flow and heat transfer at high temperatures would be an advantage. **REF. RES/J.6**

Please quote above references in applying
to L. P. LAIDLAW, PERSONNEL OFFICER
(TECHNICAL STAFF), PILKINGTON BROTHERS
LIMITED, GROVE STREET, ST. HELENS, LANCASHIRE

OPPORTUNITY FOR APPLIED SCIENTISTS

Original creative Scientists having wide experience in the practical application of Electro-Mechanical Systems Engineering are afforded the opportunity to join a team of Engineers responsible for new Products Development: Basic qualifications must include First Class Honours Science Degree and Corporate Membership of Professional Engineering Institution.

The qualities of the successful candidates will include a lively and versatile mind capable of inspiring Laboratory R. & D. studies that embody customer requirements, and the personality necessary to pursue negotiation at all levels with Establishments and Research Departments to ultimate Production Contracts. An interesting progressive and rewarding career is assured. Salary scale £3,000 or more per annum; Car: Full fringe benefits. Concise replies with all relevant facts in strict confidence to:

The Technical Director,

PREMIER PRECISION LTD

Consultant Technologists in Electronic and Hydraulic Dynamics

WESTERN ROAD, BRACKNELL, BERKS.

BRACKNELL 2222

DESIGN, RESEARCH,
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metals

We have several vacancies in our Metallurgy Division for Physicists, Chemists and Metallurgists with good honours degrees. We are a large research organisation, and among the many projects in which we are at present interested are:

1. **The Preparation of High Strength Steels.**
2. **Studies on the Deposition of Metals.**
3. **The Surface Phenomenology of Plutonium.**
4. **The Development of Joining Techniques from Beryllium.**

Salaries range between £850 and £1,900 according to age and experience, and if you are married we may offer you housing or substantial assistance with house purchase. For further details why not write to the Senior Recruitment Officer, United Kingdom Atomic Energy Authority, A.W.R.E., Aldermaston, Berks., quoting Ref. 3233A/215.

metals

WILKINSON SWORD (ACTON) LIMITED

PHYSICAL CHEMIST

Expansion of our Acton laboratories has resulted in a vacancy for a qualified chemist to undertake a range of interesting and exacting duties of an electro chemical nature, involving the development of new techniques for depositing a range of materials on precision components. Applicants should be qualified in physics or physical chemistry, preferably with some post graduate experience.

This vacancy is permanent and progressive.

Apply giving full details of qualifications and previous experience to **Personnel Officer, Wilkinson Sword (Acton) Ltd., Sword Works, Southfield Road, London, W.4.**

CHEMICAL PLANT DESIGN COMPUTERS

We are looking for a Young Man or Woman with either a good honours degree or equivalent and three or more years' experience in industry on the design of chemical plant or with a Ph.D. gained by work on a project connected with the design or performance of chemical plant. The successful applicant will be required to work largely on his or her own initiative on a study of the application of both analogue and digital computers to equipment design in the chemical field with a view to examining their feasibility and economical or other advantages. Opportunity will be given for the successful applicant to master the techniques of analogue and/or digital computers if they have no previous experience of these. This project has the support of D.S.I.R.

The salary will depend on qualifications and experience and will be on a scale to a maximum of £1,200. Conditions are those normally applicable to Institutions of University status. Persons interested are invited to write informally in the first instance giving brief details of age, qualifications and experience to.—

D. K. Houtby,
Principal Lecturer in Chemical Engineering,
Bradford Institute of Technology,
Bradford, 7,
Yorkshire.

ALLEN & HANBURYS LTD

WARE, HERTS.

invite applications from graduates in biological sciences for a position in the Toxicology Department of their Research Division. The work involves a study of the effects of known and new drugs on animals. Applications should be sent to the Personnel Manager, quoting ref. No. T.D.8.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE

Department of Botany

RESEARCH ASSISTANT. Applicants should be graduates in Botany and will be expected to engage in research, preferably in plant physiology or experimental plant ecology. Salary scale £900 p.a. Further particulars can be obtained from the Registrar, University College, Cathays Park, Cardiff, by whom applications (3 copies) giving the names of two referees, must be received not later than 28th March, 1964.

MATERIALS ENGINEERING

Vacancies exist in the Materials Branch for qualified Chemists, Metallurgists and Physicists to develop new processes for use in the aircraft and light engineering fields. Opportunities exist to develop new processes on a production basis. A degree or equivalent qualification, in Chemistry, Metallurgy or Physics is essential.
Ref: RE/C/80

MATHEMATICIAN/ENGINEER

Required by Theoretical Studies Unit to carry out numerical analysis and preparation of work for computing section or digital computer. Duties will also include the examination of methods of numerical analysis as applied to aircraft automatic control problems. Knowledge of an EMIDEC 1101 or similar computer would be an advantage. The successful candidate will lead a small section, responsible to the Head of Theoretical Studies. A degree in Mathematics is a necessary qualification. Ref: RE/C/44/3

Apply in writing, quoting the appropriate reference, and giving full particulars of age, qualifications, present salary and salary envisaged, to:

The Personnel Manager
S. SMITH & SONS (ENGLAND) LTD.
Aviation Division
Bishops Cleeve
NR CHELTENHAM, Glos.

APPOINTMENTS BOARD OF THE UNIVERSITIES OF NEWCASTLE AND DURHAM

Applications are invited from men and women for the post of ASSISTANT APPOINTMENTS OFFICER. The person appointed will be chiefly concerned with students and graduates in Science subjects, in Durham. Possession of a degree in science and experience of work in a field or fields in which science graduates are commonly employed are both essential. Employment experience should not have been exclusively in the field of education. The post is tenable from 1st August, 1964.

The salary will be at an appropriate point on the Lecturers' scale (£1,250-£2,150). Family allowances payable; membership of F.S.S.U. required.

Further particulars may be obtained from the Registrar, The University, Newcastle upon Tyne 2, with whom applications (three copies), together with the names and addresses of three persons to whom reference may be made, should be lodged not later than two weeks after the appearance of this advertisement. (Candidates outside the British Isles may submit one copy only.)

THE UNIVERSITY OF MANCHESTER

Chemist

Applications are invited for the post of Chemist at the new 100 Kw Research-Reactor at Risley, Nr. Warrington, Lancashire, operated by the Universities of Liverpool and Manchester, to be commissioned early in 1964

The applicant should have a good background of research in Chemistry, preferably with some experience in Radio-Chemistry or isotopes, and will be responsible for the development of techniques and apparatus for use in Radio-Chemistry studies on the reactor.

Commencing salary, depending on qualifications and experience, within the range £1,100-£1,400, with superannuation and child allowance where applicable. Further particulars may be obtained from the Bursar, the University of Manchester, Oxford Road, Manchester, 13. The closing date for applications is 4th April, 1964.

SOLID STATE AND THE C.E.G.B.

At the Leatherhead Laboratories of the Central Electricity Generating Board, a new and expanding Solid State Physics Section is bringing a fundamental approach to new materials and ideas that may be important to the industry in the decades ahead.

Superconductors are a good example. The new 'high-field' materials are of obvious relevance to our magneto-hydrodynamic (MHD) generation research and indeed to any ultimate thermo-nuclear fusion generator. We have a strong interest in the physics of such materials and one of our projects is aimed at a better understanding of their high current carrying capacity and its relationship to the theory of Type II superconductors. We will be using both ultra high vacuum and unconventional metallurgical approaches to this problem. Our earlier work on the alternating current behaviour of hard superconductors is already in print.

Other materials of interest are **disordered semiconductors**, among them certain compounds which pass smoothly from the glassy to the liquid state on heating with no change in electrical activation energy and which in addition are remarkably insensitive to 'doping' in the usual semiconductor sense. Very little is known about the conduction mechanism in these materials and we hope to discover more. We suspect that they may be relatively insensitive to radiation damage and, if this proves to be so, we shall have a better means of measuring temperature inside nuclear reactors.

In parallel with these investigations we are assisting with studies of the cryogenic and electrical problems that would be involved in the design of a **full-scale superconducting magnet system** for an MHD generator. Such a system would have a stored energy as high as 10_4 Megajoules and presents a great many challenges to the ingenious engineer.

Oxide films, and the transport of material through them, understandably attract a great deal of research in any industry concerned with high temperatures. The contribution of the Solid State Physics Section in this direction is a characteristically fundamental one—through the understanding of the behaviour of **oxide** single crystals. As a tractable starting point we have chosen Rutile (TiO_2) and have developed a novel method of growing and purifying single crystals of this insulating refractory oxide involving floating-zone melting and controlled departures from stoichiometry. One of our objects is to establish the principal ionic defect in the material and to this end we are employing electron spin resonance at liquid helium temperatures, which technique is also revealing new information on the semiconductivity of doped and reduced rutile.

Our area of interest is growing and may well extend to the semi-conductivity of ferroelectric materials, to phenomena applicable to radiation dosimetry, to the theory of the reverse breakdown of junctions and to corrosion theory.

At the moment the section is undergoing a modest expansion and would welcome enquiries from interested physicists. Particularly good opportunities exist for:

a) A SENIOR MAN WITH A GOOD BACKGROUND IN SUPERCONDUCTIVITY

b) A VERSATILE SOLID STATE THEORETICIAN WITH AN INTEREST IN ONE OR MORE ASPECTS OF OUR WORK, and

c) A PHYSICIST OR ELECTRICAL ENGINEER OF SOME EXPERIENCE TO WORK ON THE FEASIBILITY OF LARGE SUPERCONDUCTING MAGNETS

Publication of results is encouraged. Permanent posts or three year Research Fellowships are available.

Some financial assistance towards housing purchase may be possible in certain cases.

Salary in Bands ranging to £2,220 or £2,730 p.a.

Enquiries, accompanied by a brief résumé of qualifications, experience and publications and quoting Ref. N.S./74, should be addressed to:— N. Berryman, M.B.E., Personnel Officer (Headquarters), 24/30 Holborn, London, E.C.1.

INTERESTED PHYSICISTS IN THE U.S.A. & CANADA

should send relevant details without delay. Interviews with the Section Head can be arranged in New York during April. Short-term Research Associateships may be available for non-British nationals.

VAPOUR PHASE CRYSTAL GROWTH

A GRADUATE SCIENTIST is required to strengthen our **RESEARCH TEAM.**

He should have a background in inorganic or physical chemistry, metallurgy, ceramics or solid-state physics, applied e.g. in semiconductors or phosphers. Age 23-30. Salary up to £1,600 p.a.

ASSISTANCE CAN BE GIVEN WITH HOUSING AND RELOCATION EXPENSES

Send résumé to:

MR. P. J. ROGERS, S.T.L. LTD., HARLOW, ESSEX

STANDARD TELECOMMUNICATION LABORATORIES LIMITED

TECHNICIAN OR SENIOR TECHNICIAN required at Royal Free Hospital Medical School for Biochemistry Department. Duties include supervision of practical classes as well as assistance with research Salary on scale £700 – £1,060 according to qualifications, plus London weighting Superannuation scheme, good holidays. Apply as soon as possible to School Secretary, 8 Hunter St., London W.C.1, with names of two referees.

MEDICAL RESEARCH COUNCIL UNIT requires a technician to assist with studies of tumour structure, blood supply and response to radiation. G.C.E. in science subjects, or Intermediate I.M.L.T. and a knowledge of histological techniques desirable. Salary according to age and qualifications in scale £400 to £1,020 p.a. plus London weighting Apply with full details to the Director, Experimental Radiopathology Research Unit, Hammersmith Hospital, Ducane Road, London, W.12.

"SHELL" RESEARCH LIMITED

require a RESEARCH ASSISTANT, preferably with an ordinary degree or equivalent in Mathematics or Statistics, in their Biometrics Unit, Tunstall Laboratory. Applicants should have practical experience in statistical methods.

Staff restaurant, excellent pension scheme, bus service to door.

Apply in writing, giving age, qualifications and experience, to:—

Personnel Division
"Shell" Research Limited
Woodstock Agricultural Research Centre
SITTINGBOURNE, Kent

PART-TIME SECRETARY required for the Department of Science and Technology of the Architectural Association School of Architecture. Morning work, 5-day week. Write giving full details to the Secretary, Architectural Association, 36 Bedford Square, London, W.C.1.

INDEXER (female) required by Commonwealth Bureau of Pastures and Field Crops, Hurley, Nr. Maidenhead, Berkshire. Salary in scale £490 — £1,092. Graduate preferred. For further details and application form apply to Director.

A PHYSICIST

and a

SENIOR MECHANICAL DESIGNER

are required by

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RADIATION GROUP OF COMPANIES

The Physicist is required to develop Laboratory and Production test equipment and must be familiar with electronic control and recording techniques

The Designer must be experienced in economic design for large batch production and new materials and production techniques.

APPLY IN GUARANTEED CONFIDENCE
to the
DIRECTOR AND GENERAL MANAGER

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

D.S.I.R. require ASSISTANT INFORMATION OFFICER in Films and Broadcasting Section at Headquarters, State House, High Holborn, London, W.C.1.

DUTIES include liaison with film producers in preparation of Departmental films and with broadcasting organisations and research laboratories involving visits to research laboratories and explaining research work to producers and others.

Good knowledge of, or keen interest in, Science and Technology required. Some knowledge of broadcasting techniques and/or experience of film production an advantage.

SALARY £635 (age 20) — £874 (age 25 or over) rising to £1,296. APPLICATION forms from The Manager (PE 1739), Ministry of Labour, Professional & Executive Register, Atlantic House, Farringdon St., London, E.C.4. Closing date 19th March, 1963.

BIRKBECK COLLEGE
(University of London)

Chemist required as Research Assistant in a project on Protein Crystallography. Candidates should have an interest in protein chemistry and the preparation of organo-metallic compounds suitable for crystallisation with proteins. Post-doctoral experience in either of the above fields would be an advantage, but an Honours Degree in Chemistry or Biochemistry would also be considered.

The appointment is tenable for three years in the first instance. Initial salary according to age and experience would be in the range £800 — £1,400 p.a., annual increments £50. F.S.S.U. benefits.

Apply as soon as possible to the Secretary, Birkbeck College, Malet Street, W.C.1, giving details of qualifications, age, and the names of two referees.

UNIVERSITY OF BIRMINGHAM
Department of Physical Metallurgy

Head of Department: Professor G. V. Raynor, F.R.S.

Applications are invited for the post of Research Associate or Senior Research Associate to undertake investigations in the field of transformations in steels. Candidates should be well qualified metallurgists and have had some research experience. The salary will be in the range £825 to £1,1000 p.a. (Research Associate) or £1,100 to £1,390 p.a. (Senior Research Associate) according to qualifications. Applications (2 copies) naming two referees should be sent to the Head of the Department of Physical Metallurgy, The University, Birmingham 15, by March 31, 1964.

INSTITUTE OF CANCER RESEARCH: ROYAL CANCER HOSPITAL (Chester Beatty Research Institute, Fulham Road, S.W.3), requires a TYPIST for bibliographical work. Duties include typing of cataloguing cards, library bulletins, bibliographies and general correspondence. Accuracy essential. Salary in region £520 — £650 according to qualifications and experience; superannuable. Apply with names of two referees to the Secretary, 34 Sumner Place, S.W.7, quoting ref: 304/B/10.

Are you the
MATERIALS SCIENTIST

to join our ultra-high pressure project which is investigating the production of new materials using pressures in the 100,000 to 200,000 atmosphere range?
You will probably have worked in solid state chemistry or physics metallurgy, ceramics or mineralology, and be well qualified. The most important qualities, however, are a desire to understand the properties of solids, an urge to produce new and useful materials, and skill and perseverance to carry through research in this challenging field.
The salary will be attractive and in the range to £2,000 p.a.

ASSISTANCE CAN BE GIVEN WITH HOUSING AND RELOCATION EXPENSES

Write for further details and an application form to:
Mr. P. J. Rogers, S.T.L., Ltd., London Road, Harlow, Essex.

STANDARD TELECOMMUNICATION LABORATORIES LIMITED

UNIVERSITY OF EXETER
Assistant Lecturer in Physics
(Two Posts)

Applications are invited for these posts from October 1, 1964.

Salary scale:
£1,000 × £50 — £1,150 per annum.

The main lines of research in the Department are Upper Atmosphere Physics and Solid State Physics. Experience in electronics and/or circuitry would be an advantage for one of these posts.

Further particulars may be obtained from the Secretary of the University, Northcote, House, The Queen's Drive, Exeter.

Closing date for applications (eight copies: one copy from candidates overseas) April 13, 1964.

THE PAINT RESEARCH STATION

Assistant Analysts: Analytical problems arising in research on paints, resins, pigments, etc. call for broad analytical interest and the application of modern instrumental techniques in micro-analysis, spectroscopy, chromatography, etc.

There are opportunities for assistants to work under experienced research graduates.

Senior Laboratory Assistants: minimum qualifications A level or O.N.C. (Chemistry).

Assistant Research Officer: qualifications preferably at H.N.C. (Chemistry) level.

Applications, with full information on age, career to date, qualifications, etc. to the Paint Research Station, Waldegrave Road, Teddington, Middlesex.

THE LONDON HOSPITAL MEDICAL COLLEGE
(University of London)

Applications are invited for a Physics Laboratory Technician with an interest in biology for a Department of Dental Anatomy and Histology. Duties will include experimental X-ray, microanalytical and electron microscopical techniques. Candidates should possess either a General B.Sc., A.I.S.T., City and Guilds or similar qualifications. Initial salary according to qualifications and experience within the range £700/£900 plus London Weighting. Applications stating age, education and names of referee to the Secretary, The London Hospital Medical College, Turner Street, London, E.1 within fourteen days.

THE ZOOLOGICAL SOCIETY OF LONDON

Wellcome Institute of Comparative Physiology

Technician, male, required in new research laboratories to join work on mammalian reproduction including field studies.

Salary dependent upon age and qualifications.

Permanent post. Non-contributory Pension Scheme.

Write, giving full details, to the Establishments Officer, Zoological Society of London, Regent's Park, London, N.W.1.

UNIVERSITY OF BIRMINGHAM
Department of Transportation

Applications are invited for appointment to a Research Fellowship from graduates with relevant qualification and post-graduate experience preferably in Control Systems or Data Processing to work on a common research project in the Departments of Transportation and Electronic and field of traffic control. The salary offered will be in the range £1,000-£1,100 p.a. together with F.S.S.U. and family allowances and will be fixed according to qualifications and experience. Applicants without adequate postgraduate experience might be considered for a research studentship. Applications (2 copies) naming two referees should be sent to the Assistant Registrar (Science), The University, Birmingham 15, by 31 March, 1964.

UNIVERSITY OF ST. ANDREWS
Queen's College, Dundee

A vacancy exists for a research technician or junior technician (male or female) in the Department of Anatomy, Queen's College, Dundee. The successful applicant will join a team of biologists working on organ culture and tissue culture and should be interested in, and preferably should have had some experience in, Chemistry and Chemical Laboratory techniques. Salary according to experience, age and qualifications, on the Technician or Junior Technician scale, and up to £750 per annum. Applications as early as possible to Secretary, Department of Anatomy, Queen's College, Dundee.

CENTRAL ELECTRICITY GENERATING BOARD
Midland Region
Research and Development Department Librarian

The post of Librarian in the Research and Development Department Laboratories located at Hams Hall Generating Station will become vacant in May 1964.

Applicants should preferably be Chartered Librarians and previous experience in a technical Library or Information Service of an Engineering or Science Group would be an advantage.

The duties of the post, besides classifying, storing and issuing scientific information, includes literature searches, scanning engineering reports for features of research and development interest and handling of enquiries. There will also be scope for developing the present services to meet the expanding needs of the department.

The salary for the appointment will be in accordance with Grade 3 of the N.J.C. Agreement. £840-£1,025/£1,095 per annum.

Applications stating age, qualifications, experience, present position and salary should be submitted to the Regional Personnel Officer, Central Electricity Generating Board, Midlands Region, 53 Wake Green Road, Moseley, Birmingham 13, by 23rd March, 1964. Please quote vacancy number 205A/64MR

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5 special vacancies
for Honours Graduate teachers

If you are under 30, with a First or Second Class Honours degree in the right subject, these vacancies represent a quite exceptional opportunity. You would be given an immediate commission, secure to the age of 55, pensionable, and with excellent pay. At the age of 40 you can expect to be a Wing Commander and earn, if you are married, as much as £2,500 a year—and there are good prospects of promotion beyond this.

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Academically you need a degree of a University in the United Kingdom, or a Diploma in Technology, with First or Second Class Honours.

Suitable subjects are aeronautical, electrical, electronic or mechanical engineering; mathematics; physics.

For full information, please write giving brief details of your qualifications and experience, to: Group Captain J. W. Allan, D.S.O., D.F.C., A.F.C., R.A.F., Air Ministry (NB120), Adastral House, London WC1

The Royal Air Force

ILFORD

require

Scientists for Technical Service

There are two vacancies for scientific staff in the Monochrome Photographic Products Division of the Company's Techno-Commercial Department.

1. A Graduate Chemist is required to operate a technical service chemical laboratory, offering analytical and other chemical services to the department.
2. A Science Graduate, preferably a Physicist, is required to set up and operate a technical service to users of photographic materials for scientific and technical applications. He will also be required to provide a photomicrographic service for the department.

It is important for both these posts that applicants should be commercially minded and able to achieve good rapport with the Company's customers.

Applications, in writing, should be sent to the Assistant Chief Personnel Officer, Ilford Limited, Ilford, Essex, quoting reference DB/PK.

NATIONAL COAL BOARD
(West Midlands Division)

Applications, preferably from graduates and those of equivalent qualification, are invited for a superannuable appointment designated ASSISTANT GEOLOGIST. The person appointed, who will be based in Stoke-on-Trent, will be required to assist in the compilation, interpretation, and correlation of geological records from tunnel drivages and boreholes.

The appointment attracts a salary, according to experience and qualification, in the range £1,118 to £1,725.

Forms of application, obtainable from the Area Staff Manager, National Coal Board, 72 Leek Road, Stoke-on-Trent, should be completed in full detail and returned within ten days of the appearance of this advertisement.

UNIVERSITY OF DURHAM
Technical Staff

A LABORATORY TECHNICIAN is wanted in the Department of Physics to work in teaching laboratories. Some knowledge of electronics an advantage. Starting salary will be at an appropriate point on the National Salary Scale for University Technicians £580-£815 a year, according to age, qualifications and experience.

Certain qualifications entitle holders to an extra allowance of £30-£50 a year.

Applicants should apply in writing, giving full details of age, education, qualifications and experience, together with names of two referees, to the Deputy Secretary, Science Laboratories, South Road, Durham.

PHYSICAL TESTING
ADHESIVE TAPES LIMITED
Boreham Wood, Herts

(manufacturers of the registered "Sellotape" brand of pressure-sensitive products and a member of the E. S. & A. Robinson Group of Companies) have an immediate vacancy for a young qualified man to assume responsibility for a development physical testing section and the introduction of new and modified tests on self-adhesive materials. Applications are sought from technical men who possess a general scientific interest and a bias towards a mechanical approach to problems.

Detailed letters of application should be forwarded to the Personnel Manager at the above address.

TECHNICIAN OR SENIOR TECHNICIAN (Zoology Department), Queen Mary College (University of London), Mile End Road, E.1. To take charge of physiological laboratory, including preparation of undergraduate practical classes and assisting with post-graduate research. Some knowledge of electronics an advantage. Appointment within the grade Technician or Senior Technician according to age, qualifications, experience. Salary scales: Technician, £550 to £815 p.a. Senior Technician, £810 to £1,018 p.a. Plus in both grades London Weighting up to £45 p.a. according to age. In addition a qualification award of £38 or £50 for certain specific qualifications. Five day week. Five weeks annual leave. Letters only to Registrar (ZTST) stating full details of experience, any qualifications, present work and age.

F. W. BERK & CO. LTD.

require an

ABSTRACTOR

We are in the process of setting up a library for our new Research and Development Centre at Harlow. Initially the successful candidate will join our Head Office staff until the new centre is completed. The work will mainly be concerned with abstracting for a new Technical Bulletin under the guidance of the Librarian but there will naturally be opportunities to undertake other library work.

The person we are seeking will be either male or female in the age group 22/30 with a degree of HNC in Chemistry.

Terms and conditions of employment are excellent and include Pension/Life Assurance Schemes and Profit Participation. Write full details age, qualifications, experience, present salary, etc., to **Staff Manager (Ref. MRI), F. W. Berk & Co. Ltd., Berk House, 8 Baker Street, London, W.1.**

BIOCHEMIST

This appointment calls for an applicant with a Ph.D. or equivalent research experience, who can play a major part in a programme of research into rumen biochemistry.

Applicants will be expected to also participate in all aspects of the work of the Technical Department laboratories, which are housed in the Company's Head Office situated in the Bath area.

The salary for this position is negotiable, dependent on age, experience. Pension and sickness schemes are in operation.

Applicants should send full details of age, experience, qualifications, publications and the names of two referees to:

Head of Technical Services,
Feed Service (Livestock) Ltd.,
Hartham,
Corsham,
Wiltshire.

UNIVERSITY COLLEGE OF SOUTH WALES AND MONMOUTHSHIRE
Department of Biochemistry

Applications are invited for the post of Research Assistant in the above department. The successful applicant will be expected to assist with the research work of Professor K. S. Dodgson and to help with the teaching activities of the department. The appointment will be for 3 years and the successful candidate will be given an opportunity to proceed to a higher degree. Salary in the range £650-£900 per annum, depending on qualifications and experience.

Applications (together with the names of 3 referees) should be addressed to the Registrar, University College, Cathays Park, Cardiff. Closing date, 31st March.

CLARE HALL HOSPITAL
South Mimms, Barnet, Herts.

(301 beds for diseases of the Chest)

PHYSIOLOGIST (non-resident) required for respiratory work. Candidates should hold an appropriate degree of a University of England, Wales, Scotland or Ireland, or a qualification approved by the Ministry of Health.

Salary £740 rising to £1,250 per annum plus London Weighting, but new entrants with First or Second Class Hons. Degree will commence at £825 per annum, plus London Weighting.

Apply to Chairman of Medical Advisory Committee, naming two referees.

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required by

THE BRITISH ALUMINIUM CO LTD

in its Intelligence Department to deal with technical enquiries and editorial work on "Aluminium Abstracts". Science graduates with knowledge of languages preferred.

Applications, which will be treated in confidence, should quote ref. AQ.23 and be addressed to the Staff Manager, The British Aluminium Company Limited, Norfolk House, St. James's Square, London, S.W.1.

IMPERIAL CANCER RESEARCH FUND

Vacancies in Division of Physiology and Endocrinology for two technicians to assist in research involving (a) biological and (b) biochemical work in the estimation of steroid and protein hormones. Salary according to age and experience, within the scale £700 x £25/30 — £860 plus London Weighting and Luncheon vouchers. Superannuation scheme. 3 weeks annual leave. Applications, giving full personal details and experience, to the Secretary (F), Imperial Cancer Research Fund, Lincoln's Inn Fields, London, W.C.2.

THE UNIVERSITY OF LIVERPOOL

Applications are invited for the following post:

Assistant Lecturer or Lecturer in the Department of Zoology. The salary will be within the range £1,000-£2,150 per annum, according to age, academic qualifications and experience.

Applications, stating age, qualifications and experience, together with the names of three referees, should be received not later than 26 March, 1964, by the Registrar, from whom further particulars may be obtained, quoting reference number CV/80/NS.

RESEARCH CHEMIST

The Company has ambitious plans within the expanding field of electronic component manufacture, and is setting up a Research team to investigate the preparation and properties of inorganic conducting materials. The vacancy is for a graduate under 50 to lead this team, who has a flair for research and is capable of original thought. Salaries are progressive. Removal expenses considered and Council housing available. Apply in confidence to Personnel Manager, Welwyn Electric Limited, Bedlington, Northumberland.

PHYSICIST & CHEMIST/PHYSICAL CHEMIST

There are two further vacancies in the Chief Scientist's Department for men or women with the following qualifications and experience:

(a) Age not over 40.
(b) University degree (not less than upper second—a higher degree (or) additional qualification would be an advantage).
(c) At least three years in industry.
(d) Knowledge in the field of semiconductor devices and materials
(e) Ability to work on the development of devices based on thin films and semiconductor transducers.

The starting salary will be in the range £1,500 to £2,000, and there will be opportunities for increased responsibility. There is a pension scheme with the usual benefits. This is an established but expanding company with one of the most modern factories of its type in Europe. The successful candidates will be working in new laboratories

Apply to: **The Personnel Manager**
VACTRIC CONTROL EQUIPMENT LTD.
Garth Road, Merden, Surrey
who will treat all applications in the strictest confidence

MANAGER OF OPERATIONAL RESEARCH DEPARTMENT

THE BRITISH OXYGEN COMPANY invites applications for the post of manager of their Operational Research Department which is located in London. Candidates would be preferred who have an honours degree in Mathematics, Engineering or Science and several years experience of operational research.

Applications giving full details of experience, qualifications, age and present salary should be addressed to the Personnel Officer,

BRITISH OXYGEN CO. LTD.
Hammersmith House, Hammersmith, W.6

WESTMINSTER HOSPITAL TEACHING GROUP

Department of Clinical Measurement

Technician required for the above Department which deals with measurement and instrumentation in the application of physiology to clinical problems. Knowledge of electronics is essential Salary according to qualifications, age and experience on the scale £649 to £809 p.a. plus London Weighting. Apply naming two referees to Secretary, Department of Clinical Measurement, Westminster Children's Hospital, Vincent Square, S.W.1

ST. PAUL'S GIRLS' SCHOOL, Brook Green, Hammersmith, London, W.6

MATHEMATICS: A vacancy will occur in September, 1964, for an Honours Graduate to teach MATHEMATICS to University Scholarship standard and throughout the school. Governors' own salary scale and State superannuation. Application should be made with testimonials to the High Mistress as soon as possible.

ELECTRONICS ENGINEER

British Nylon Spinners Limited has vacancies in the Instrument and Electronic Section of the Experimental Engineering Group for young Physicists, Electrical and Electronic Engineers. Applicants should have good qualifications and be capable of devising new methods of control and instrumentation.

The current problems involve microwaves, digital electronics, strain gauges, servomechanisms, synchronous motors, heat transfer and optics. One vacancy exists for a candidate with a special interest in pressure transducers.

The Section is supported by a large workshop, an advanced scientific photographic service, an analogue computer and a wide range of commercial electronic equipment.

Modern techniques, with a bias towards semi-conductor circuitry, are constantly in use. Facilities are available, also, for producing printed circuits within the Section.

Engineers are encouraged to publish papers and maintain contact with Universities.

Assistance is given to married men moving into the area. Superannuation and profit sharing schemes operate.

Please write, quoting E.61, to—

The Personnel Manager,
British Nylon Spinners Limited
Pontypool, Monmouthshire

STUDENTSHIPS

UNIVERSITY OF ABERDEEN

Department of Soil Science

Two tutorial studentships are offered from October 1st, 1964, one to a person qualified in physics and the other in geology/mineralogy.

Tutorial students are required to assist with tutorial and practical classes and to undertake research for an M.Sc. or Ph.D. degree. Appointment will be for up to three years at £550 per annum plus demonstration fees

Opportunities will be given to study some physical aspect of the water balance in soils and some mineralogical features of soils.

Candidates should have good honours degrees, or their equivalent, or expect to graduate this session. Applications should be submitted before March 15th, to the Secretary, University of Aberdeen, from whom particulars may be obtained

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FELLOWSHIPS, GRANTS AND SCHOLARSHIPS

UNIVERSITY OF LONDON. Applications are invited for IMPERIAL CHEMICAL INDUSTRIES RESEARCH FELLOWSHIPS in Biochemistry, Chemistry, Chemotherapy, Engineering Metallurgy, Pharmacology or Physics. The Fellowships will normally be tenable from 1st October, 1964, for three years. The salary, which will depend upon qualifications and experience, will normally be in the range of £1,000-£1,200 per annum, but awards up to £1,500 per annum may be made in the case of engineers and technologists where industrial experience or other special circumstances warrant it Family Allowance and F.S.S.U. Detailed regulations and application forms may be obtained from the Academic Registrar, University of London, Senate House, W.C.1 Applications must be received not later than 1st April, 1964.

THE UNIVERSITY OF MANCHESTER

Graduate School of Politics and Public Administration

About fifteen places will be available to British students who wish to enter the Graduate School in October, 1964 and applications are invited from graduates and from those graduating in the summer of 1964, provided they are of first class or good upper second class quality. Recent Government announcements indicate that grants will be available for such students.

The Robbins Report makes it clear that there will be a serious shortage of good graduates in the social sciences during the next five years. We are therefore ready to accept applicants graduating in related Arts subjects, such as history, philosophy and modern languages, or in scientific discipline which train students in statistics and the use of mathematical models.

For further particulars apply to the Chairman, Graduate Studies Committee, Department of Government, Manchester University, Manchester 13.

BATTERSEA COLLEGE OF TECHNOLOGY

Applications are invited for a SENIOR RESEARCH FELLOWSHIP or RESEARCH FELLOWSHIP in THEORETICAL NUCLEAR PHYSICS. The research in this department is concerned with the structure of light nuclei and hyperfragments. Salary scales £1,645-£2,210 or £1,245-£1,460 p.a., according to age and experience. Further particulars may be obtained from Dr. L. R. B. Elton, Head of the Department of Physics at the College, London, S.W.11, to whom applications should be sent as soon as possible.

UNIVERSITY OF LONDON: Applications are invited for a TURNER & NEWALL RESEARCH FELLOWSHIP in Engineering, Inorganic Chemistry or Physics. The Fellowship will normally be within the range of £1,000-£1,200 per annum and will normally be tenable from 1st October, 1964, for three years. Family Allowance and F.S.S.U. Detailed regulations and application forms may be obtained from the Academic Registrar, University of London, Senate House, W.C.1. Applications must be received not later than 1st April, 1964.

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FURNASCOTE for speedy, low-cost repair of refractories. Keeps your furnaces in action. Gives gas tight, acid-resisting, monolithic coatings. Write: FURNASCOTE LTD., SOUTHAMPTON. Tel. Locksheath 3372.

LECTURES, MEETINGS AND COURSES

UNIVERSITY OF LONDON

Department of Extra-Mural Studies

The following University Extension Residential week end course has been arranged for graduates in physics or engineering, or holders of equivalent qualifications:

Telecommunication

At Moor Park College, Farnham, Surrey, from 13-15 March, 1964. The lecturers will include Professor Colin Cherry and Mr J. J. Sparkes. The widening field of interest in 'communication' since the Second World War will be considered, and preparations for the future discussed.

Inclusive fee: £3 10s.

Applications should be made to the Deputy Director (Ex N.), Department of Extra-Mural Studies, Senate House, W.C.1, and should include all the following information: full names, age, relevant qualifications and work done.

POSTAL TUITION

for G.C.E. (O and A levels), London Univ., B.Sc., B.A., B.Sc.(Econ.), LL.B., and for professional examinations. Prospectus (mention exam) from E. W. Shaw Fletcher, C.B.E., LL.B., Dept. SN9, WOLSEY HALL, OXFORD. (Estb. 1864.)

Equip yourself for a career in Programming

Recognizing the present acute shortage of skilled computer programmers, NCR is able to offer training courses to suitable applicants. These will be held after normal working hours and will be concentrated VOCATIONAL PROGRAMMING COURSES at inclusive fees as shown below.

The next series of these courses will be held in the Computer Education Centre at the address given below from 5.30 to 9.00 p.m. on Monday, Tuesday and Thursday of each week.

There will be two courses available, one on the National-Elliott 803 computer lasting for five weeks at a fee of 30 guineas and the other on the NCR 315 computer lasting for nine weeks at a fee of 50 guineas.

Although applications are welcome from men and women aged from 19 to 35, whether beginners or otherwise, it is essential for each applicant to pass an Entry Aptitude Test to ensure that he or she is suitably qualified to study the subject.

Successful applicants will be taught the techniques of programming and should acquire sufficient knowledge to enable them to start "on the first rung of the programming ladder".

The fee may be paid, if required, by instalments during the course, with a booking fee on enrolment.

The programming profession offers tremendous opportunities with many challenging assignments. We are interested in giving students a chance to embark on an interesting career by making available, on a non-profit basis, the full facilities of our premises, equipment and teaching staff.

The two courses will start on 6th April, 1964.

Interested applicants should send full details (including age, academic qualifications, experience, if any, and course required) to the address given below.

THE NATIONAL CASH REGISTER CO. LTD.
COMPUTER EDUCATION CENTRE
88 BAKER STREET, LONDON, W.1

Brighton Education Committee

BRIGHTON COLLEGE OF TECHNOLOGY

Department of Computing, Cybernetics and Management

A SHORT COURSE IN ANALOGUE COMPUTING TECHNIQUES

March 18th-20th, 1964

This five day course, for professional engineers, scientists and mathematicians, comprises an Introduction to the General Purpose Analogue Computer and some of its applications to the study of Differential Equations, the Design and Analysis of Servo-Systems, Chemical Engineering, Production Enginerring and Economic Simulation.

Lectures on these topics will be given in the mornings; the afternoons will be given over to practical work. Three General Purpose Analogue Computers will be available for practical work.

Fee for the course, including coffee, lunch and tea, is Ten Guineas.

Hotel accommodation for the week can be arranged for those requiring it. Enrolment forms for the course and further information may be obtained from the Head of the Department of Computing, Cybernetics and Management, Brighton College of Technology.

W. G. Stone, Director of Education,
Moulsecoomb, Brighton 7.

THE MANCHESTER COLLEGE OF SCIENCE AND TECHNOLOGY

A short course of lectures on

Public Health Responsibilities in Radiation Protection

will be held in the College on

Thursday and Friday, April 18 and 17, 1964

The fee for the course is £7, inclusive of lunch and light refreshments.

Accommodation in a Hall of Residence can be arranged, if required, at a reasonable additional charge.

Further particulars and form of application can be obtained from the Registrar, The Manchester College of Science and Technology, Manchester 1.

TELEVISING PARLIAMENT?

A chance to discuss this at Caxton Hall, S.W.1, on Tuesday, 17th March, 7.38 p.m. Further info. from the TV Viewers' Council, 35 Queen Anne Street, W.1. (LAN 2155).

LOUGHBOROUGH COLLEGE OF TECHNOLOGY

Loughborough, Leicestershire

Undergraduate Course in Ergonomics and Cybernetics

Applications are invited from prospective students, both men and women, for entry to a new undergraduate course in Ergonomics and Cybernetics starting in September, 1964. Following acceptance of the recommendations of the Robbins Committee this course can be expected to lead to the award of a degree.

The Course will appeal to students, including those due to leave school this year, with an interest in the application of the biological and engineering sciences to problems of men, machines and environment.

Further particulars and forms of application may be obtained from the Academic Registrar.

BRADFORD INSTITUTE OF TECHNOLOGY

Department of Chemical Engineering

Recent Advances
in

MASS TRANSFER

A conference will be held
4th-8th MAY, 1964

The scope will cover principal mass transfer operations, together with a consideration of control problems and the application of computers to plant design. Contributors will include leading workers from both academic and industrial spheres in Great Britain and the Continent.

Further details may be obtained from the Registrar, Bradford Institute of Technology, Bradford, 7.

UNIVERSITY CORRESPONDENCE COLLEGE

Postal tuition for LONDON UNIVERSITY Entrance requirements and DEGREES (B.Sc., B.Sc.(Econ.), Advanced Levels), Diploma in Mathematics, and EDUCATION (all Examining Boards, Ordinary and B.A., LL.B., etc), GENERAL CERTIFICATE OF many other exams. Moderate fees. Free Prospectus from the Registrar, 28 Burlington House, Cambridge.

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THE COLLEGE OF AERONAUTICS CRANFIELD

Department of Aerodynamics
Short courses

AERODYNAMIC PRINCIPLES OF THE HELICOPTER

4th to 8th May, 1964

The course will include discussions on the basic principles of rotary-wing and other VTOL systems, their design problems and future trends.

Fees, covering tuition, full board and accommodation, 22 guineas.

PROBLEMS IN HYPERSONIC AERODYNAMICS

10th to 22nd May, 1964

The course is intended for aerodynamicists, physicists and research workers who require a working knowledge of hypersonic aerodynamics. A knowledge of subsonic and supersonic aerodynamics and of mathematics up to a degree level is desirable.

Fees, covering tuition, full board and accommodation, 40 guineas.

Forms of enrolment from the Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks.

ROYAL COLLEGE OF ADVANCED TECHNOLOGY, SALFORD

Department of Electrical Engineering

One-Year Postgraduate Course in

Instrumentation and Control

A full-time postgraduate course of three terms' duration (October-June) will be available from October, 1964. The aim of the course is to provide a thorough understanding of the basic theory and practice of control engineering, with particular emphasis on the application of electronics in this field. The main subjects covered in the course are:

Electrical Networks and Feedback Systems
Electronic Devices and Circuits
Electrical Transducers and Measuring Systems
Control System Design
Computing Methods.

On satisfactory completion of the course, which includes a minor research project, students will be eligible for the College Diploma in Advanced Studies, awarded on the results of an examination and thesis.

For acceptance on the course applicants must hold a qualification of degree level in engineering or applied science.

Preliminary application should be made to the Head of the Department of Electrical Engineering as soon as possible, when further particulars will be supplied.

LIVERPOOL EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY
Byrom Street, Liverpool 3

Department of Electrical Engineering

The Department is offering the following short courses:

PROGRAMMING OF ELECTRONIC ANALOGUE COMPUTERS (Practical Work provided)—April 8th, 9th, 10th, 1964.

AUTOMATIC CONTROL OF MACHINE TOOLS—April 14th and 15th, 1964.

Further details can be obtained from the Head of Department.

T. ALKER,
Town Clerk and Clerk to the
Local Education Authority

Postgraduate Courses at

CRANFIELD

Mechanical Engineering and Applied Mechanics

The College of Aeronautics offers one-year and two-year postgraduate courses in the following subjects:

Fluid Mechanics · Solid Mechanics and Structures
Mechanical Engineering · Applied Mechanics
Gas Turbine Technology · Combustion Technology
Heat Transfer · Fuels and Lubricants

The College's laboratories are exceptionally well-equipped for experimental work and include wind tunnels, test installations, measuring equipment of all kinds, and digital and analogue computers. Individual research or design projects are normal features of the courses.
Candidates should be graduates in engineering, physics, or mathematics, or have equivalent qualifications.
All courses are residential. Scholarships and bursaries are available. *Further information from:*

The Registrar, The College of Aeronautics,
Cranfield, Bletchley, Bucks.

CHELSEA COLLEGE OF SCIENCE AND TECHNOLOGY

Department of Physics

Postgraduate Course in Solid State Physics

Applications are invited from graduates in Physics or from holders of the Diploma in Technology or from those expecting to graduate in 1964, for admission to a one-year full-time postgraduate course in Solid State Physics, commencing October 5th, 1964.

The course is approved by the D.S.I.R. for the tenure of Advanced Course Studentships, and suitable qualified students may be registered for the M.Sc. degree of the University of London and for the College Diploma.

Further information and application form from the Secretary, Physics Department, Chelsea College of Science and Technology, Manresa Road, London, S.W.3 (Flaxman 6421).

ROYAL COLLEGE OF ADVANCED TECHNOLOGY, SALFORD

Department of Electrical Engineering

Post-H.N.C.—Full-time course in Electrical Engineering

A full time course of about eight months' duration (October-May) is provided by the Department of Electrical Engineering in preparation for the Part III examination of the Institution of Electrical Engineers. This course allows Graduate Membership of the Institution of Electrical Engineers to be obtained in one year as opposed to the two or three years required to cover the syllabus by part-time study.

For entry to the course, students must have passed or be exempt from all subjects of the I.E.E. Part I examination and from the electrical subjects and mathematics of the I.E.E. Part II examination.

Prospective candidates for the course commencing in October 1964 should apply to the Head of the Department of Electrical Engineering for further particulars.

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will cater for specialists in—
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FREE TUITION MINISTRY OF EDUCATION GRANT SCHEME
Applicants should possess good qualifications such as a University Degree or Diploma, Dip Tech., H.N.D. or H.N.C., or corporate membership of a professional institution.
For further details write to one of the following:

The Principal,
Garnett College,
Downshire House,
Roehampton Lane,
London, S.W.15

The Director,
Training College for Technical Teachers,
Holly Bank Road,
Lindley,
Huddersfield

The Director,
Bolton Training College,
Chadwick Street,
Bolton

The Principal,
Wolverhampton Technical Teachers' College,
Wulfruna Street,
Wolverhampton

Please quote reference S.33

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